NVE

# Gap Analysis of Implementation of the Myanmar Grid Code

## Based on a study in Myanmar Sept/Oct 2015

Gap Analysis

2015-11-23 Ordernr.: 5154196

Norconsult

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|---|---|---|---|---|---|
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# Foreword

There are currently a draft Myanmar Grid Code dated September 30 from 2013.

The draft Grid Code consists of seven main parts and one part with definitions.

Draft Grid Code Volumes:

- General Conditions
- Connection Code – specifies certain principles and establishes a set of minimum technical, design, and operational conditions for the users for connecting to and using the Transmission System.
- Planning Code – framework for enabling the TSO and users to interact with each other in relation to planning and development of the National Electricity Transmission System.
- Operation Code – sets out the responsibilities and roles of the participants as far as the operation of the National Electricity Transmission System is concerned.
- Scheduling and Dispatch Code – specifies the responsibilities and obligations of the TSO and users with respect to scheduling and dispatch of generating units and other demand resources.
- Data and Information Exchange Code – sets out the obligations and responsibilities of the TSO and users in relation to the supply of data and information to each other, and also lists the various categories of data and information to be exchanged between the TSO and the users.
- Metering Code – metering and recording requirements for participants and clarifies on their obligations relating to such installations. It also sets the minimum technical, design and operational criteria to be complied with by users relating to metering and data collection equipment and installations.

Grid Code regulations set forth in these drafts are very detailed. For a future power system of Myanmar a process to have the entire organisation to work with the same objectives for the Grid Code is the best. The study in Myanmar Sept. /Oct. 2015 identified a gap between current practice and the proposed regulations.

Based on discussions with MOEP, visit to a number of important power- and substations as well as interview of personnel at these stations, we have made this report.

The present practice differs from the Draft Grid Code. We find parts of the content of present Grid Code more relevant for a future grid in Myanmar. Those parts have not yet been considered in MOEP and we will not make any comments to them in this report.

This report focusses on quoted parts of the draft and our comments are, in principle, *written in italic and highlighted like this*.

# 1 Grid Code and distribution Code Gap Analysis

Based on the situation as we learned to know it during the first days of our visit to Myanmar, we adjusted the Terms of Reference in agreement with NVE:

- To find out what will be the appropriate manner and timeframe for the implementation of the Grid and Distribution Codes, we will obtain information and knowledge about how the current practice differs from the drafted Codes by visiting different sites and have discussions with the site staff as well as MOEP staff in Nay Pyi Taw.
  Interviews/mapping in Myanmar according to a detailed plan.

- Arrange a workshop with relevant staff in MOEP presenting some suggestions for the stepwise introduction of a Grid Code. MOEP is at the present busy with planning and implementation of many new projects and the introduction of a Grid Code initially have to be very simplified. The most important issues have to be identified and focused on in order to get the best results and to prepare for a safe and well-organised operation of existing and new installations.

- Preparation of Final Gap Analysis Report.

The present 230 kV National Grid of Myanmar has been built during the last 30 - 40 years but most of the powerlines and substations are from the last decade. Before this time, the Grid was fragmented and available for some parts of the country only. This means that the national grid company MOEP has been established to plan, operate and maintain a national grid in a relatively short time.

The growth in consumption is about 12-15 % a year in the cities and such a huge growth means a very busy organization. If this organization is going to deal with a Grid Code, the Grid Code have to be simplified and introduced to the organization in a process oriented way.

The present draft Grid Code is more like a Grid Code meant for a well-established and experienced organization.

We were able to visit the sites we had on our plan and we met the staff of MOEP on all these sites. The staff were interviewed and we had a brief look at the equipment.

Based on this we will concentrate our comments on the parts of Draft Grid Code relevant for the present MOEP organization. Parts of the Draft Grid Code not commented are not implemented in the present organization.

# 2 Objectives of present draft Grid Code

## 2.1 FOREWORD OF PRESENT DRAFT GRID CODE

The Grid Code has been developed to define the rules and regulations for various participants for accessing and using the Transmission Grid of the Republic of the Union of Myanmar. The objective is to establish the obligations of the Transmission System Operator (TSO) and other Grid Users – Generators, Distribution Entities, and directly connected Customers for accessing and using the Grid.

The Grid Code is designed to indicate the procedures for both planning and operational purposes and covers both normal and exceptional circumstances. It is however a live working document. It will be, from time to time, subjected to changes and/or revisions to reflect stages of development of the regulatory framework of the electric power sector and changes to comply with legislations and good industry practices.

# 3 I. General Conditions

Part I contains provisions which are of general nature and apply to all sections of the Grid Code. Their objective is to ensure, to the maximum possible extent, that the various sections of the Grid Code work collectively and in harmony with each other for the benefit of all participants.

## 3.1 THE SPECIFIC OBJECTIVES OF – "GENERAL CONDITIONS" ARE:

(i) clarify on the legal and regulatory framework for implementing and enforcing of the Grid Code

(ii) specify the purpose, functions, and composition of the Grid Code Supervisory Committee (GCSC)

(iii) describe the framework for making amendments to the Grid Code and for seeking derogations from its provisions

(iv) define general rules regarding the communication between the TSO end users and exchange of data and information between them

(v) specify the general rules for interpreting the provisions of the Grid Code

## 3.2 *COMMENTS*

*We have seen that there are still ongoing work regarding the General Conditions.*

*In this study, we have made no registration of the actual status of the General Conditions. We consider the MOEP organization to be in a very early stage of dealing with the Grid Code and regulatory framework.*

*The organization is still on its way to find the suitable size for the responsible units to deal with the different items in the Grid Code.*

*During our visits to different parts of the organization, we found that the Draft Grid Code was not very well known in the organization.*

*We are not able to evaluate any Gap concerning the General Conditions.*

## 3.3 *QUESTION TO MOEP*

*A questionnaire was sent to MOEP before the visit and a number of answers was received.*

| ***Grid Code ref.*** | ***Part I: 12. COMMUNICATION BETWEEN THE TSO AND USERS*** |
|---|---|
| *Norconsult question* | ***Have you established a secure way of communication between the IPP's and TSO?*** |

| | |
|---|---|
| | *With this, we mean standardized messages, acknowledgement of messages etc. in order to make no room for misunderstandings causing wrong actions. This applies for both administrative as well as operational communication.*<br><br>*Furthermore, do you keep a time stamped copy of the messages regardless of the message being verbally or electronically?* |
| *MOEP reply* | *1. At the Real Time operation, relative communication between MEPE's control centre (National or Regional) and IPP are conducting by directly or indirectly by linking substation or Power Plant these are state own facility.*<br><br>*2. For conducting the operational data of the IPP's Power Plant to the under implementation of MEPE's SCADA system that is the responsibility and investment of the IPP.*<br><br>*3. For the schedule, outage either party shall be notify by written letter prior the relevant shutdown to another party.*<br><br>*4. In the PPA, it is clearly mentioned the address for the communication of both parties.*<br><br>*5. We keep a time stamped copy regarding the operational communication.* |

# 4 Connection Code

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## 4.2 INTRODUCTION

TSO needs to have Grid Code conditions fulfilled to let a new system connect and use the transmission system. In MOEP the present system mostly consists of grid owned by the operator. Some IPP units are connected to the grid. All units have been specified by different consultants and delivered and commissioned by contractors. This means there have been no unified Grid Code in the system at present.

In the following only relevant chapters from the table of content are commented.

Draft Connection Grid Code intends to:

1. Specify certain principles and establishes a set of minimum technical, design, and operational conditions for the users for connecting to and using the Transmission System, hereafter referred to as the Transmission System. The purpose is to protect the facilities of the Transmission System as well as the plant and apparatus of the users, and to ensure safe, stable, and secure operation of the system. This Code also provides details on the performance characteristics of the Transmission System at the connection point to enable the users to design their own facilities accordingly and to provide suitable control and protection schemes for them.

2. In addition to this Connection Code, there may be additional provisions in the individual connection agreements between the TSO and the users, defining, in greater detail and in more specific terms, the mutual obligations of each party.

3. Connection Code details involves the following participants:
   - (i) Generators (other than those which only have Embedded Power Stations);
   - ~~(ii) Transmitters;~~
   - (iii) Distribution Service Operators (DSO);
   - (iv) Embedded Generators (EGs);
   - (v) Transmission System Operator (TSO); and
   - (vi) Customers.

4. If the relevant licence has been obtained from the Electricity Regulatory Body (Generation, Transmission, Distribution) and appropriate processes followed in terms of technical connection conditions by any prospective participant (Generator, Transmitter, Distribution Service Operator, Embedded Generator or Customer), Transmission System (TS) and Distribution System (DS) open access shall not be denied by any DSO, TSO or TransCo.

## 4.3 OBJECTIVES

The objectives of the draft Code are the following:

(i) to provide a set of fair and non-discriminatory basic rules and standards for accessing and using the transmission system which must be complied with by all users;

(ii) to specify the normal transmission system performance standards at the connection Point;

(iii) to specify the technical design and operational criteria at the connection point; and

(iv) to clearly define the technical function, operational criteria, and ownership of the equipment connected to the Transmission System in accordance with the relevant site responsibility schedule.

## 4.4 GRID CONNECTION PROCEDURE

### 4.4.1 Grid Impact studies

*Consultants do this from time to time and case-by-case. At present MOEP do not have their own total consistent database to be able to do these studies regularly.*

### 4.4.2 Application for a New – or Modification of an Existing – Connection

*No prescribed application form from the TSO available from the office of Manager, Transmission Asset Planning Department of the TSO.*

### 4.4.3 Connection Agreement

*The Connection Agreement between the User and the TSO following a new connection – or modification of an existing connection* is *made by MOEP. SAT prcedures must be part of this agreement.*

### 4.4.4 Commissioning of Equipment and Physical Connection to the Grid

*Upon completion of the user installation including work at the connection point, the equipment at the connection point and the user plant shall be subject to commissioning tests procedure as specified in “Commissioning Tests” of the delivery specified by the contractor.*

*No MOEP “Commissioning Tests” available.*

### 4.4.5 Question to MOEP

*A questionnaire was sent to MOEP before the visit and a number of answers was received.*

| **Grid Code ref.** | **Part II: 4. GRID CONNECTION PROCEDURE** |
|---|---|
| Norconsult question | **How do you handle a new connection today?**<br>Does the TSO receive an application from a potential IPP or is MOEP selling concessions according to their need?<br>Does the TSO make Grid Impact Studies from case to case, or has it already been made for many years ahead? |
| MOEP reply | Yes, the TSO make Load Flow Study from case to case according to the estimated commercial operation year and we have been already made for 5 years ahead. |

## 4.5 TRANSMISSION SYSTEM PERFORMANCE

### 4.5.1 General Provisions

The TSO shall strive to maintain the Transmission System performance within the limits and ranges specified in the Minimum National Power Quality Standards for the Myanmar Transmission

Grid. Until such time, the TSO shall strive to maintain the Transmission System performance within the limits and ranges as specified in this section.

Users shall ensure that their plant and apparatus at connection points are also designed and operated such that these operate satisfactorily within the specified limits and ranges to be set out in the Minimum National Power Quality Standards. Until such time, the limits and ranges as specified in this section shall be adhered to.

### 4.5.2 *Frequency Variations*

1. The Frequency of the Transmission System shall be nominally 50Hz and shall be controlled within the limits of 49.5 - 50.5Hz unless exceptional circumstances prevail.

2. The System Frequency could rise to 52.0Hz or fall to 47.0 Hz in exceptional circumstances. Design of user's plant and apparatus must enable operation of that plant and apparatus within that range in accordance with the following:

| Frequency Range: | Requirement: |
|---|---|
| 51.5Hz - 52Hz | Operation for a period of at least 15 minutes is required each time the Frequency is above 51.5Hz. |
| 51.0Hz - 51.5Hz | Operation for a period of at least 90 minutes is required each time the Frequency is above 51Hz. |
| 49.0Hz – 51.0Hz | Continuous operation is required. |
| 47.5Hz - 49.0Hz | Operation for a period of at least 90 minutes is required each time the Frequency is below 49.0Hz. |
| 47.0Hz - 47.5Hz | Operation for a period of at least 20 seconds is required each time the Frequency is below 47.5Hz. |

For the avoidance of doubt, disconnection, by frequency or speed based relays is not permitted within the frequency range 47.5Hz to 51.5Hz, unless agreed with the TSO.

Other users should ensure that their equipment is designed or protected for these exceptional circumstances.

*Comment: The requirement passed onto an IPP today is 48.5 ~ 51.5 (±1.5) Hz.*

## 4.6 VOLTAGE VARIATIONS

1. The voltage at any point on the Transmission System will normally remain within ±5% of the nominal value as stated in the table below, unless abnormal conditions prevail. The minimum voltage is -10% and the maximum voltage is +10% unless abnormal conditions prevail, but voltages between +5% and +10% will not last longer than 30 minutes unless abnormal conditions prevail as stated below.

| Nominal Voltage (kV): | Normal Range: | 30-Minute Over & Under-Voltage: |
|---|---|---|
| 500kV | ± 5 % | ± 10 % |
| 230kV | ± 5 % | ± 10 % |
| 132kV | ± 5 % | ± 10 % |
| 66kV | ± 5 % | ± 10 % |

2. The TSO and a user may agree greater or lesser variations in voltage to those set out above in relation to a particular connection site, and insofar as a greater or lesser variation is agreed, the relevant figure set out above shall, in relation to that user at the particular connection site, be replaced by the figure agreed.

*Comment: These are the present settings in Myanmar. The requirement passed onto an IPP today is ± 10%.*

### 4.6.1 Harmonic Distortion

*Comment: Not controlled at present. Some Steel mill customers have their own equipment to control.*

### 4.6.2 Transient Voltage Variations

*Comment: Not controlled at present. Some Steel mill customers have their own equipment to control.*

### 4.6.3 Earthing

1. For connections to the Grid at all nominal system voltages, the Grid is solidly earthed with specified earth fault factor below 1.4 (Refer to IEC Standard 60071-2 “Insulation Coordination”).

2. The TSO shall specify in the connection agreement the earthing requirements and the applicable earth fault factor at the connection points, if an exception is to be permitted in certain cases.

*Comment: Not controlled at present. However, we observed a number of poorly done connection at the substations we visited.*

## 4.7 PLANT AND APPARATUS AT CONNECTION POINTS

### 4.7.1 General Provisions

1. Each connection between a user and the Transmission System shall be controlled by a suitable isolating device (isolating switch or circuit breaker, as determined by the TSO) capable of interrupting at the connection point, the short circuit currents specified in the relevant connection agreement.

2. The user shall be responsible to ensure that all the user plant and apparatus, including protection schemes, are tested and maintained and remain rated for the duty required of them.

3. Users shall own, operate, and maintain all the facilities beyond the connection point.

4. The TSO shall own, operate, and maintain all the facilities up to and including those at the connection point.

5. The user shall comply with the operating instructions of the TSO with regard to various systems (including all plant and/or apparatus) required to control electric power and energy to (or from) that user's facility.

*Comment: OK*

### *4.7.2 Protection Equipment/Schemes*

1. All users shall be responsible for providing protection for the equipment and facilities at their respective sides when connected to the Transmission System.

2. All user protection schemes, relays and their settings shall require prior coordination with and approval of the TSO's relevant protection engineering office.

3. The protection schemes shall isolate the faulty section and equipment in case of fault with the dependability, selectivity, speed, and sensitivity as defined in the applicable connection agreement or the Grid Code.

4. The protective equipment connected to the Transmission System shall be tested to achieve the specified level of dependability, selectivity, speed, and sensitivity in fault clearing and to minimize the impacts on the Grid.

5. The protection scheme's ability to initiate the successful tripping of the circuit breaker which is associated with the faulty equipment shall be measured by system protection dependability index exceeding 99%.

6. Users shall comply with the following requirements for fault clearance times (from fault inception to circuit breaker arc extinction) by primary protection not exceeding:

| Network Category: | Fault Clearance Times: |
|---|---|
| 500kV | 80 milliseconds |
| 230kV | 100 milliseconds |
| 132kV | 120 milliseconds |
| 66kV | 120 milliseconds |

The probability that these times will be exceeded for any given fault must be less than 1%.

7. To safeguard against failure of the primary protection systems provided to meet the above fault clearance time requirements, the users shall also provide backup protection, which shall have fault clearance time slower than that specified for the user primary protection. The TSO shall also provide backup protection, which shall have fault clearance times slower than those of the user backup protection.

8. In case of the failure to trip of a user's circuit breaker provided to interrupt fault current interchange with the Transmission System, circuit breaker fail protection shall be provided to trip all necessary electrically adjacent circuit breakers within 300 milliseconds. The design reliability for protection shall be equal to or greater than 99%.

9. Fault Disconnection Facilities:

Where no circuit breaker is provided at the user connection point, the user must provide to the TSO all necessary facilities and schemes to isolate with discrimination and as necessary the faults or grid abnormalities, due to the user connection, on the Transmission System. In these circumstances, for faults on the user system, the user protection should also trip higher voltage circuit breakers in the Transmission System. These tripping facilities shall be in accordance with the requirements specified in the relevant connection agreement.

10. Loss of Excitation Protection for Generating Units:

The Generator must provide protection to detect loss of generating unit excitation and initiate a trip of the associated generating unit.

11. Pole Slip Protection for Generating Units:

Where, in the TSO's reasonable opinion, system requirements dictate, the TSO will specify in the connection agreement and/or use of system agreement a requirement for generators to fit pole slip protection on their generating units.

12. Access to Protection Equipment at Connection Points:

No busbar protection, mesh corner protection, circuit breaker fail protection relays, AC or DC wiring (other than power supplies or DC tripping associated with the user's plant and apparatus) shall be worked upon or altered by, or on behalf of, a user in the absence of a representative of, or written authority from, the TSO.

13. Automatic Switching Equipment:

Where automatic re-closing of circuit breakers of the Transmission System is required following faults on the user system, automatic switching equipment shall be provided in accordance with the requirements of the relevant connection agreement.

14. Relay Settings:

(i) Protection and relay settings shall be coordinated by the TSO and user(s) across the connection point in accordance with the connection agreement to ensure effective disconnection of faulty apparatus. In case of a dispute between any parties on such issues, the TSO shall be the final deciding authority.

(ii) The TSO may install special protection schemes to safeguard against collapse of the System for any foreseeable situation, e.g. during high summer load seasons. In the event of loss of major transmission line(s) leading to voltage collapse in the Transmission System, the TSO may need to resort to a large scale load shedding to halt damaging voltage collapse which may lead to brownouts and eventual blackouts.

*Comments:MOEP has become a big national grid operator during the last 10 years. There are only one office dealing with the maintenance of relays and relay schemes. This means that the settings are not checked regularly and relay schemes not sufficiently corrected. Probably there are lot of bugs in the present relay settings.*

### 4.7.3 Operation and Maintenance Safety Conditions

1. All users responsible for the operation and maintenance shall also be responsible for the safety of equipment, persons, and facilities at their respective sides connected to the Transmission System. On safety issues, users shall follow the procedures as laid down in Section 11 “Cross-boundary Safety Assurance” of the Operation Code and the Safety Rules referred to in that section.

*Comment: Not a routine at present.*

2. Site responsibility schedule as provided in Section 8.5 “Site Responsibility Schedules” hereafter will specify the ownership responsibilities of each user connecting to the Transmission System for the following:

   (i) ownership of the plant/equipment;

   (ii) the responsibility for operation and maintenance;

   (iii) safety rules and procedures; and

   (iv) control of plant/equipment and facilities at their respective side.

*Comment: Not a routine at present.*

### 4.7.4 Metering

Metering equipment shall be installed at connection points in accordance with the provisions of the connection agreement and the standards defined in the Metering Code.

*Comment: OK. Manual routines. Metering data telephoned to MOEP every day.*

### 4.7.5 Requirements for Generators

1. All generating units must be capable of supplying rated active power output at any point between the limits 85% power factor lagging and 95% power factor leading at the generating unit terminals, unless otherwise agreed expressly by the TSO in the connection agreement.
2. All generating units must be capable of continuously supplying their rated active power output at the generating unit terminals within the System frequency range 49.5 to 50.5 Hz. Any decrease of active power output occurring in the frequency range 47.5 to 49.5 Hz should not be more than a proportionate decrease in the frequency.

3. The active power output at the generating unit terminals under steady state conditions should not be affected by voltage changes in the normal operating range specified in Section “Voltage Variations” here above.
4. Transformation ratio and tap changer of step up transformer and the auxiliary services transformer, as well as the voltage range and excitation of the generating unit shall be designed and adjusted so that the generating unit is at normal operating voltage of the Grid, capable of producing or absorbing (as the case may be), continuously the reactive power defined by the capability curve of the generating unit (at generating unit voltage level). The generating unit’s continuous reactive power capability shall not be restrained by main or auxiliary equipment, control and protection or operating procedures.
5. The generating unit shall be capable of absorbing continuously the reactive power (under excitation operation) defined by the capability curve of the generating unit also at maximum voltages of the Grid assuming that stability is maintained.
6. The reactive power output at the generating unit terminals under steady state conditions and at rated active power should be fully available within the range ± 5% of nominal voltage at the connection point.
7. The TSO may require a black start capability from certain strategically located generating units/stations. In such cases, generators will provide black start capability through an agreement with the TSO. If an agreement cannot be reached on this issue, the TSO or the generator shall refer the matter to the Electricity Regulatory Body for resolution. Generators, committing to provide black start capability, shall also allow to the TSO access to their black start units for testing and drills as and when required by the TSO.
8. In case the system frequency momentarily rises to 51.5 Hz or falls to 47.5 Hz, all generating units shall remain in synchronism with the Transmission System for the operating times stated in Section 5.2 “Frequency Variations” above to allow the TSO to undertake measures to correct the situation. Each generating unit must be capable of contributing to, in a manner satisfactory to the TSO, frequency and voltage control by modulation of active power and reactive power supplied to the Transmission System or a user system.
9. The system frequency could vary within the limits given in Section “Frequency Variations” above and generating units are required to be capable of satisfactory operation at any frequency within this range unless the TSO has agreed in the connection agreement to the use of any frequency-level relays and/or rate-of-change- frequency relays which will trip generating unit within this frequency range.
10. Each generating unit shall be fitted with a fast-acting speed governor system to provide power and frequency control under normal operating conditions. The speed governor system shall be designed and operated freely to regulate system frequency and shall have adjustable governor droop setting within 2% to 8%. The normal set point will be generally at 5%. Total governor dead-band (inherent plus intentional) should be 0.05 Hz or less. The above droop and dead-band requirement shall apply for an entire combined-cycle generation facility. Users shall not change frequency or load related control settings of speed governors without the prior agreement of the TSO. In islanding situations, the generating unit’s speed governor system must also be able to operate at a frequency range between 47.5 Hz and 51.5 Hz.
11. Each generating unit shall be equipped with high response excitation system with continuously acting Automatic Voltage Regulation (AVR) system to control the unit terminal voltage. The AVR shall be designed and operated to maintain the steady-state terminal voltage within ± 0.5% of the set point in the normal voltage range as specified in Section 5.3 “Voltage Variations” above without instability over the entire operating range of the unit. Ceiling voltage for static exciters shall be at least twice, and for brushless exciters at least 1.6 times the rated field voltage of the generating unit. The excitation system shall be capable of supplying its ceiling voltage for 10 seconds. Generators shall not disable this automatic control mode without prior approval of the

TSO. Each generating unit shall be required to include Power System Stabilizing (PSS) and var limiting equipment as well.

12. On-load tap changing facilities shall be required on generator step-up transformers for dispatch of reactive power. The transformer voltage ratio, tapping range, and step sizes must be such that the reactive power requirements specified in Section 6.5 (6.) are fully complied with.
13. The TSO shall be entitled to acquire such operational metering, control parameters, and plant data as it may reasonably require for the purposes of discharging its statutory and regulatory obligations.
14. A generating unit, and the station in which the generating unit is located, must be capable of continuous uninterrupted operation for the voltage variation specified in Section 5.3 “Voltage Variations” above, and for faults on the Transmission System which may cause the voltage at the connection point to drop to between 0% and 80% of the nominal voltage for a period of up to 300 millisecond in any one phase or combination of phases, followed by a period of one (1) second where voltage may vary in the range 80-110% of the nominal voltage, and a subsequent return of the voltage within the range 90-110% of the nominal voltage.
15. Generating units shall be capable of withstanding, without tripping, a negative phase sequence loading appropriate to their rated full load in accordance with the IEEE Standard C37.102-1995: IEEE Guide for AC Generator Protection. In addition they shall be required to withstand, without tripping, the negative phase sequence loading incurred by clearance of a close-up phase-to-phase fault by backup protection on the user system of which they are a part.
16. The higher voltage windings of the generating unit step-up transformer connecting the generating unit to the Transmission System must be star connected with the star point grounded in accordance with IEEE Standard C37.101-1993: IEEE Guide for Generator Ground Protection. If adjacent to a TSO substation, it shall be connected to the grounding system of that substation.
17. Generators will be responsible for protecting their generating units against the risk of any damage which might result from any frequency excursion outside the range 47.5 Hz to 51.5 Hz and for deciding whether or not to interrupt the connection between his plant and/or apparatus and the Transmission System in the event of such a frequency excursion.
18. Following the disconnection from the Grid, the generating unit/station must change over to house load operation for one (1) hour.
19. Control synchronizing shall be provided by generators at circuit breakers identified by the TSO, which, depending on the plant configuration, shall include:
    (i) the generating unit circuit breaker; and
    (ii) the generator transformer HV circuit breaker.
20. The TSO will provide to the generator signals from the TSO operated plant and apparatus as required to facilitate synchronizing on the generator transformer HV circuit breaker or the generating unit circuit breaker (as agreed with the TSO), in accordance with the relevant connection agreement. The synchronizing facilities as stated in Section (19.) above shall facilitate synchronizing under the following conditions:
    (i) Transmission System frequency within the limits specified in Section “Frequency Variations”;
    (ii) Transmission System voltage within the limits as specified in Section “Voltage Variations”.

*Comment: This chapter of the Draft Grid Code is very important. The settings mentioned must be calculated for the actual Grid of Myanmar. The international standards mentioned are universal and will assure a high quality of the equipment in a delivery.*

*The biggest units are capable of supplying rated active power output between some limits. All present units are installed before the draft Grid Code was presented.*

*This means that for new units to be set in operation the Grid Code provisions will have to be taken care of.*

*By doing the stability analysis for the grid from time to time the mentioned parameters in the Grid Code could be made more up to date for the actual need to take care of stationary and dynamic stability.*

*Values presented in the Grid Code must be part of the education for the staff in MOEP in order to know how to deal with these in daily operation.*

*The draft Grid Code is important to be included in tender documents for new generating units.*

### 4.7.6 Requirements for Distribution Entities and Directly-connected Customers

1. At nominal system voltages of 132 kV and above, the higher voltage windings of three phase transformers and transformer banks connected to the Transmission System, if star-connected, shall have their star point suitable for connection to earth. For this purpose neutral connection must be brought out of the tank to enable external connection to the earth. The earthing and lower voltage winding arrangement shall be such as to ensure that the Earth Fault Factor requirement as stated in Section (1.) “Earthing” above of the Grid Code are satisfactorily met on the Transmission System at nominal system voltages of 132 kV and above.

*Comment: This is a routine at present but the SAT routines are not satisfactory.*

2. As required in the Operation Code, each distribution entity shall make arrangements that shall facilitate automatic low frequency disconnection of demand. The connection agreement shall specify the manner in which demand subject to low frequency disconnection shall be split into discrete MW blocks with associated under frequency relay settings. Technical requirements relating to under frequency relays will be specified in the connection agreement or relevant standards.

*Comment: This is a routine at present but the SAT routines are not satisfactory.*

3. The under frequency relays for automatic load shedding shall be provided at the connection point by the users as per the connection agreement. The TSO may allow a user to have such schemes installed on user side of the connection point providing that, if considered necessary and required by the TSO, 100% of the user load may be shed.

*Comment: This is a routine at present at some installations but the SAT routines are not satisfactory.*

4. Distribution entities and directly-connected customers shall ensure that the power factor at the connection point does not fall below 85% lagging at any time and shall provide appropriate power factor improvement facilities to ensure that.

*Comment: This is not a routine at present.*

5. Reactive power compensation shall be provided by the distribution entities at low voltage system close to the load point to avoid excessive reactive power losses and to enable the TSO to maintain the Transmission System voltage within the limits as specified in Section "Voltage Variations" above.

*Comment: This is not a routine at present.*

## 4.8 SYSTEM SERVICES

The relevant connection agreement or power supply or purchase agreement (as the case may be) will contain requirements for the capability for certain System Services from the following list which may be needed for proper System operation:
(i) voltage control and reactive power support (when used exclusively for such purpose);
(ii) primary control of generating units;
(iii) secondary control of generating units;
(iv) black start capability;
(v) operating margin (operating/contingency reserve);
(vi) interruptible load; and
(vii) any other system service.

*Comment: This is an important issue in the agreements, but not satisfactorily dealt with in the present agreements.*

## 4.9 SITE RELATED CONDITIONS

### 4.9.1 Responsibility for Operation and Maintenance

In the absence of an agreement between the parties to the contrary, operation and maintenance responsibilities shall follow ownership.

*Comment: This is not a routine at present.*

### 4.9.2 Responsibilities for Safety

1. Any user entering and working on its plant and/or apparatus on a site of the Transmission System shall work to the TSO safety rules.
2. The TSO entering and working on its plant and/or apparatus on a user site shall work to the TSO safety rules. However, for user sites where the TSO staff may be exposed to some special risks (for instance, hazardous or toxic substances or gases, etc.), the TSO, in addition to its own safety rules, will follow the user safety rules also.

*Comment: This is not a routine at present. No safety rules at present.*

### 4.9.3 Site and Equipment Identification and Labelling

1. The TSO shall provide to each user details of the current numbering and nomenclature system of the Transmission System to enable the user to plan the numbering and nomenclature of its own (E)HV plant and apparatus on the connection site.

*Comment: No numbering and nomenclature in routine at present. This must be established. The SCADA system is prepared to deal with the normal 4 stage labelling. B1, B2, B3 and B4.*

2. The party installing plant and/or apparatus shall be responsible for providing and installing of clear and unambiguous labels showing the site and equipment identification at its respective system.

*Comment: No nomenclature in routine at present in MOEP.*

3. The numbering and nomenclature of each item of plant and/or apparatus shall be included in the operation diagram prepared for each site.

*Comment: This is not a routine at present.*

4. For plant and/or apparatus of the Transmission System on a user site:
   (i) If the TSO intends to install its E(HV) plant and/or apparatus on a user site, it shall notify the relevant user of its intent in writing by showing the proposed plant and/or apparatus, with clear numbers and nomenclature, on an operation diagram and by giving date of the proposed installation, at least six (6) months ahead of the proposed installation.
   (ii) the relevant user will confirm to the TSO in writing within one (1) month of the receipt of such notification, either its acceptance of the TSO proposal or objection(s), if any, by stating the reasons for the objection(s).
   (iii) the relevant user will not install, or permit the installation of, any (E)HV plant and/or apparatus on such user site which has numbering and/or nomenclature which could be confused with that of (E)HV plant and/or apparatus of the Transmission System already on that user site or about which the TSO has notified to that user that it intends to install on that site.

*Comment: This is not a routine at present.*

5. For user plant and/or apparatus on the sites of the Transmission System:
   (i) If a user intends to install its (E)HV plant and/or apparatus on a site of the Transmission System, it shall notify the TSO of its intent in writing by showing the proposed plant and/or apparatus, with clear numbers and nomenclature, on the operation diagram and by giving date of the proposed installation, at least six (6) months ahead of the proposed installation.
   (ii) (ii) the TSO will respond in writing to the user within one (1) month of the receipt of the notification either confirming its acceptance of the user proposed numbering and nomenclature or, if they are not acceptable, by giving details of the numbering and nomenclature which the user shall adopt for that (E)HV apparatus.

*Comment: This is not a routine at present.*

6. Changes If the TSO intends to change the existing numbering or nomenclature of either its own (E)HV plant and/or apparatus on a user site or of the user (E)HV plant and/or apparatus on a site of the Transmission System:

(i) the provisions of paragraph (4.) of this Section shall apply to such change of numbering or nomenclature of the (E)HV plant and/or apparatus of the Transmission System with any necessary amendments to those provisions to reflect that only a change is being made; and

(ii) in the case of a change in the numbering or nomenclature of (E)HV plant and/or apparatus of the user on a site of the Transmission System, the TSO shall notify the user of the numbering and/or nomenclature that the user shall adopt for that (E)HV plant and/or apparatus at least six (6) months prior to the change being needed and the user will respond in writing to the TSO within one (1) month of the receipt of the notification, confirming receipt. In either case, the notification shall indicate the reason for the proposed change.

*Comment: This is not a routine at present.*

### *4.9.4 Connection Point Drawings*

*Comment: Single line diagrams are made for all connection points. This is part of routine at present. MOEP has a Grid Code for this. Labelling is not sufficient as mentioned in above.*

## 4.10 MAINTENANCE PROCEDURES

1. User plant and apparatus on the sites of the Transmission System shall be maintained adequately (not less than the TSO standards) by the user or the TSO if agreed in the connection agreement, for the purpose for which it is intended and to ensure that it does not pose a threat to the safety of any of the plant, apparatus, or personnel on the site of the Transmission System. The TSO shall have the right to inspect the test results and maintenance records relating to such plant and/or apparatus at any time. The TSO shall also have the right to inspect the user equipment at the connection point, if considered necessary by the TSO.
2. All the TSO plant and/or apparatus on user sites shall be maintained adequately (not less than TSO standards) by the TSO and notified as such in the connection agreement, for the purposes for which it is intended to ensure that it does not pose a threat to the safety of any of the user plant, apparatus, or personnel on the user site.

*Comment: MOEP have no routines for this. Preventive maintenance is totally missing. Repair maintenance are available for some substation installations.*

## 4.11 SITE OPERATIONAL PROCEDURES

The TSO and the users must make available staff to take necessary safety precautions and carry out operational duties as may be required to enable work/testing to be carried out and for the operation of plant and/or apparatus connected to the System.

*Comment: MOEP have only repair maintenance available in some installations.*

## 4.12 *FINAL COMMENTS CONNECTION CODE*

### *4.12.1* Gap between actual routines and the present Connection code

*We have made some comments to this part of the Grid Code because we find it very important for the organisation to incorporate improved routines to deal with the connection.*

*There are just a few routines established for connection.*

*Normally the routines in the technical contract are used for connection SAT. MOEP do not have a routine listed from Grid Code for use in the connection conditions.*

*Normal voltage and frequency ranges are part of the conditions set in the connection agreement.*

# 5 Planning Code

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## 5.2 INTRODUCTION

The TSO shall have the primary and lead responsibility for planning the grid development, including carrying out of all necessary studies, assessments, and evaluations.

In planning for grid development, the TSO may require a user, or a group of users, to modify or install new plant and/or apparatus, where the TSO reasonably considers that it is prudent or necessary to do so to ensure continued compliance with the requirements of the Grid Code.

*In the following only relevant chapters from the table of content are commented.*

Planning Code:

1. This Code provides a framework for enabling the TSO and users to interact with each other in relation to planning and development of the National Electricity Transmission System hereafter referred to as the Transmission System. It also specifies the information and data that the users shall provide to the TSO or the TSO shall provide to the users for this purpose.

2. All users, existing as well as prospective, will be bound by the planning conditions laid down in this Code prior to generating, transmitting, distributing, or consuming electricity, as the case may be.

## 5.3 OBJECTIVES

The objectives of this Code are to specify:

(i) the responsibilities of the TSO and users towards grid planning;
(ii) the mechanism for the TSO and users to interact with each other with respect to any proposed development on the user system that may have impact on the Transmission System;
(iii) the power system studies required and the planning criteria and standards to be followed by the TSO to ensure efficient, safe, reliable, and economic operation of the Grid;
(iv) the data and information required from users for use by the TSO to plan for grid development; and
(v) the data and information to be provided by the TSO to users to aid them to plan and decide for their own facilities.

## 5.4 GRID PLANNING STUDIES

The TSO shall conduct grid planning studies periodically or on as required basis to ensure the economic, safe, reliable, and stable functioning of the Transmission System, specifically for the following:

(i) preparation of the transmission forecast statement for next five years;
(ii) preparation of transmission development plans;
(iii) evaluation of grid reinforcement/extension projects;
(iv) evaluation of any proposed user development submitted to the TSO in accordance with an application for a new, or modification of an existing, connection;
(v) to assess the impact on the Transmission System or on any user system of any demand forecast or any proposed addition or change of equipment or facilities in the Transmission System or the user system and to identify remedial measures to eliminate the deficiencies in the Transmission System or the user system;
(vi) to assess the behaviour of the Transmission System during normal and contingency conditions;
(vii) to assess the system behaviour during the electromechanical or electromagnetic transients induced by disturbances or switching operations; and
(viii) any other planning assessment that may be required in the future to ensure adequate transmission capacity.

The grid planning studies may include studies (as the situation or case may demand) such as load flow studies, short-circuit studies, transient stability studies, steady state stability studies, voltage stability studies, electromagnetic transient studies, and reliability studies, etc.

## 5.5 GRID PLANNING PROCESS

1. For the development of the Transmission System, the TSO shall follow a planning process divided into major activities as follows:
   (i) needs identification;
   (ii) formulation of alternative options to meet this need;
   (iii) studying these options to ensure compliance with agreed technical limits, and justifiable reliability and quality of supply standards;

(iv) costing these options on the basis of present-day capital costs and using appropriate net discount rates, establish the net present cost of each option;
(v) determining the preferred option;
(vi) building a business case for the preferred option using acceptable justification criteria, and
(vii) requesting approval of the preferred option and initiating execution.

2. The TSO shall prepare Transmission System development plans with a minimum window period of five (5) years and preferably 10 to 15 years, indicating the major capital investments planned (but not yet necessarily approved). These Transmission System development plans shall be reviewed at the least every 2 years by the TSO.

3. Users, existing as well as prospective, will be able to assess conditions for connecting to, and using of, the Grid through the following:
   (i) a forecast statement, prepared by the TSO, showing the opportunities available for connecting to, and using of, the Grid and indicating those parts of the Grid that are most suited to new Connections and transport of further quantities of electricity; or
   (ii) an offer by the TSO to enter into a connection agreement with a user for connection to, or use of, the Grid.

4. To enable the TSO to properly plan for Grid development, users will be required to submit to the TSO all data that the TSO may require from them for this purpose. The details of the data requirements from users for planning purposes are set out in the following Section "Submission of Grid Planning Data".
5. Any user proposing to close, retire, withdraw from service, or otherwise cease to maintain and keep available for dispatch in accordance with good industry practice, any generating station or generating units with registered capacity greater than ten (10) MW in aggregate shall give the TSO at least twenty-four (24) calendar months' notice of such action.

## 5.6 *INTERVIEWS/MAPPING - PLANNING CODE*

### *5.6.1 Mapping*

*According to the MOEP planning organisation the present situation is:*

**1** *Grid planning is not entirely done by TSO. But, it is needed to be done by TSO for the Future after stipulating the grid code.*

**2** *The rapid development in the private sector building IPP's shall be developed according to the Grid Code.*

**3** *The followings are the procedure of the Existing Grid Planning:*

*(a) Power Demand Forecast is done up to year 2030 and is mainly based on GDP, Previous Power Demand Growth Rate and Population. Generation Plan is done accordingly by the method of energy security. (Scenario 3; NEMP by JICA).*

*(b) All the projects of Generation and Transmission are done by MOEP Owned Budget, Loan and Deferred Payment Loan.*

*(c) The Process of the Project is two type; Direct Contract and Competitive Bidding.*

*For the Direct Contract Projects of Generation, the process stages are*
*1 MOU*
*2 FS*
*3 MOA*
*4 JV/ BOT*
*5 MIC Permit*
*6 PPA*
*7 LLA*
*And then, the project is started.*

*(d) For the Competitive Bidding Projects of Generation, the process stages are*
*1 LLA*
*2 Bid Permit*
*3 FS*
*4 MOA*
*5 MIC*
*6 PPA*
*7 LLA*
*And then, the project is started.*

*(e) For the Transmission Projects,*
*1 The Loan Projects are done according to their Guidelines.*
*2 MOEP owned Budget and Deferred Payment Loan Project are done as the following;*
*a Bid Permit*
*b Tendering Process*
*c Contract*
*And then, the project is started.*

***4*** *For Planning Concept of transmission project is based on Generation Plan, Demand Requirement and Power System Reinforcement.*

***5*** *The Period for all Planned Projects is based on their type and size.*
*Grid Planning data for the 5 succeeding years is attached in excel format.*

## 5.7 *FINAL COMMENTS PLANNING CODE*

### 5.7.1 Gap between actual routines and the present Planning Code

*MOEP have developed a Grid Code for planning during some years. This is based on the need for some routines and instruments to deal with the rapid growth in electricity consumption.*

*Present Grid Code Planning is not in accordance with the draft Grid Code.*

# 6 Operation Code

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## 6.2 INTRODUCTION

Operation and supervision of the National Electricity Transmission System is an important daily activity. Without an organized operation, breakdown and blackout might occur within very short time.
Responsibilities and roles of the participants as far as the operation of the National Electricity Transmission System hereafter referred to as Transmission System is concerned.

## 6.3 OBJECTIVES

1. This code sets out the responsibilities and roles of the participants as far as the operation of the National Electricity Transmission System hereafter referred to as Transmission System is concerned, and more specifically issues related to:
   (i) reliability, security and safety;
   (ii) market operation actions required by the Transmission System Operator (TSO);
   (iii) system services;
   (iv) independent actions required and allowed by customers;
   (v) operation of the Transmission System under abnormal conditions; and
   (vi) Field operation, maintenance and maintenance co-ordination / outage planning.

## 6.4 OPERATION ACTIVITIES LISTED IN THE DRAFT GRID CODE

The chapters 2-4 are dealing with the activities needed to have a long term stable and secure grid operation. Items included in this activity are:

a. Back office activities of the operation:
   - safety and security
   - demand forecast
   - outage planning
b. Online operation
   - frequency control
   - voltage control
   - system control
   - operational margin
   - black start (real and training)
c. Communication
   - Data
   - Telephone
d. SCADA system
   - operation (staff)
   - maintenance of system
   - training of personnel
   - functionality, recording
   - RTU communication
e. Contingency planning
   - grid operation (possibilities in a case of abnormal operation)
   - demand control
   - system restoration planning
f. Testing of system in order to withstand abnormal circumstances.
g. Testing to verifying that the users are operating within their design, operating and other contractual requirements, as specified in the relevant connection agreement between the user and the TSO.

## 6.5 INTERVIEWS/MAPPING - OPERATIONAL CODE

### 6.5.1 Mapping

*MOEP have established a set of procedures and routines for operation and maintenance of switchgear and power plant interconnections.*

## 6.6 FINAL COMMENTS OPERATIONAL CODE

### 6.6.1 Gap between actual routines and the present draft Operational Code

*Present draft Operational Code is very detailed and is more suitable for a developed organisation.*

*MOEP have just put into operation a new modern SCADA system. The staff is gaining experience continuously in operation of the system. Training of the staff is done regularly by the contractor.*

*Comments to activities listed in chapter 6.4:*

- *(a) The mentioned back office demand forecast activities are made by the generating company and only for the dry season. Changes in the organisation have to be done in order to get this done by the operational staff.*
  *Safety and security are not part of the daily routines. Outage planning is made by NCC to take care of Repair maintenance and load shedding.*
- *(b) Online operation are made by the SCADA staff. At present the SCADA system does not have sufficient telecommunication to the RTU units. This affect the possibility to get correct and time stamped information in a case of failure and to make correct operations. Organisational changes must be done in order to enable the staff in the operation centre to do the remote operation of the switches in the grid.*
- *(c) Communication is partly based on mobile telephone. This is not sufficient in a case of a severe outage as mobile base stations are dependent of electrical supply. High voltage line carrier (PLC) are mainly used for the remote communication in the present situation. A change in the system using optical fibre (OPGW) are under commissioning. This will improve the communication.*
- *(d) SCADA system need to have correct information, i.e. to show the real situation. At present, the staff do not update the system when changes are made in the grid due to insufficient organisational authorization.*
- *(e) Contingency planning is not possible until the online data connection are improved. This activity need sufficient correct data from the RTU units.*
- *(f and g) Testing need some systematic routines in the Grid Code. In the present situation these are not made. Testing is made as a part of the contracts when new equipment is commissioned.*

*There are a gap between present Grid Code and draft Grid Code at most of the theme.*

# 7 Scheduling and Dispatch Code

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## 7.2 INTRODUCTION

This chapter specifies the responsibilities and obligations of the TSO and users with respect to scheduling and dispatch of generating units and other demand resources. It sets out the procedure for supplying of timely and accurate information by the Users to the national Transmission System, the TSO's preparing and issuing of generation schedules, and issuing of dispatch instructions.

Chapter is divided into two sections:

- Generation Scheduling
- Generation Dispatch.

Generation Scheduling, deals with submitting of availability notices and relevant information by generators and any modification to them subsequently, if required. The section also describes the procedure to be followed by the TSO for preparing and issuing of generation schedule to specify which generating units may be required for dispatch. This section also details the special actions that the TSO may require from users to match supply with demand and ensure the requisite stability and reliability on the transmission grid. Section 4, Generation Dispatch, deals with dispatch of generating units and executing of other special actions to minimize cost of supply procurement while ensuring the availability of adequate level of operating margin and other system services.

## 7.3 OBJECTIVES

The objective of this chapter is to enable the TSO to schedule and dispatch adequate generation resources to meet electricity demand at all times at minimum cost while ensuring the integrity of the system, as well as the requisite levels of supply quality and reliability.

## 7.4 *INTERVIEWS/MAPPING – SCHEDULING AND DISPATCH CODE*

*This has been checked out with the control centre (NCC) staff which at the moment have an activity on this topic when there is a lack of available power in the dry season. Then NCC makes a plan and LDC execute the dispatch operation.*

*Generation Scheduling is done by the General Control Centre (GCC) for the dry season. GCC controls the hydropower and coal-fired power plants.*

*Generation Dispatch are Based on the generation schedule prepared and issued in accordance with the provisions of Generation Scheduling. The GCC will issue dispatch instructions to generators due to the Dispatch plan.*

*Dispatch of active power and reactive power are initiated by NCC and issued by GCC.*

*In Myanmar two or three hydropower units are used for adjusting frequency and voltage. These units are operating with automatic voltage regulator (AVR), VAR limiters, and power system stabilizers (PSS). This is due to requirements under their respective connection agreement. AVR is in service at all times unless released from this obligation by the TSO.*

## 7.5 *FINAL COMMENTS SCHEDULING AND DISPATCH CODE*

### *7.5.1 Gap between actual routines and the present draft Scheduling and Dispatch Code.*

*All activity concerning Scheduling and Dispatch are made by NCC, LDC and GCC. See organisation chart next page.*

*This means that NCC will have to contact LDC and GCC in order to execute adjustments in generation and demand control.*

*This is a very slow action and are not sufficient for a future Grid Code.*

*Organisational changes will have to be done. Merging of SCADA system and organisation for the units NCC and LDC are needed.*

*GCC should have all power production and make a daily (hourly detailed) offer to NCC/LDC telling which units are available at which time and with which amount of power.*

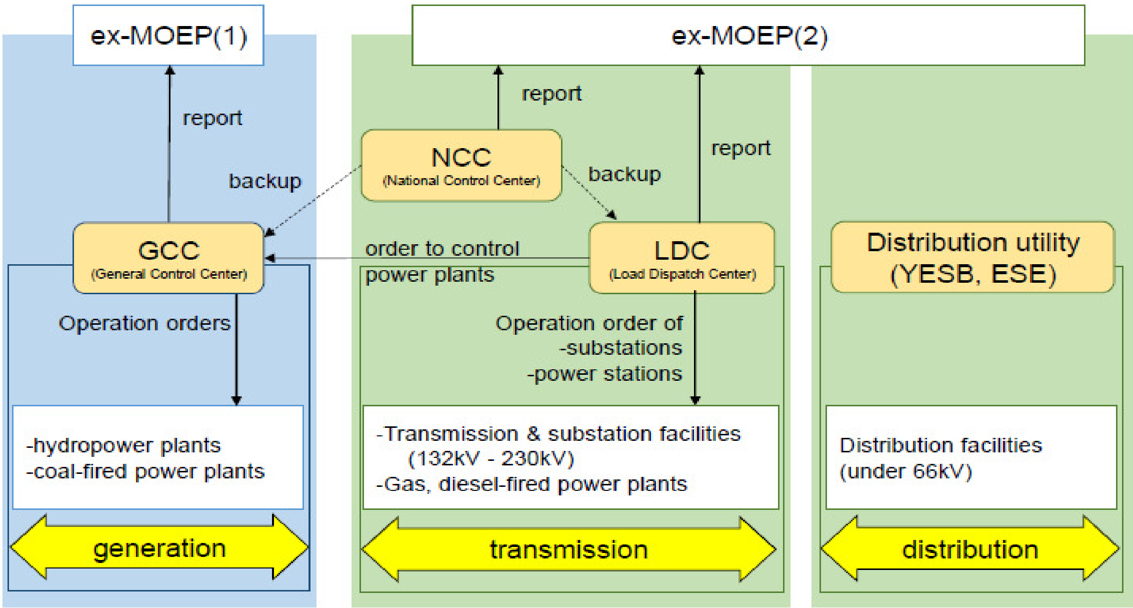


*Fig. 6.3-1 Duty Structure of Power System Operation*

*Present organisation of MOEP.*

# 8 Data and Information Exchange Code

## 8.1 TABLE OF CONTENTS FOR THE DRAFT EXCHANGE CODE

1. INTRODUCTION ........ 3
2. OBJECTIVES ........ 3
3. DATA AND INFORMATION CATEGORIES AND REGISTRATION ........ 3
4. PROCEDURE AND OBLIGATIONS ........ 4
5. DATA AND INFORMATION SUBMISSIONS ........ 4
6. DATA AND INFORMATION TO BE REGISTERED ........ 5

## 8.2 INTRODUCTION

The proper and timely exchange of data and information between the TSO and users is critical for ensuring non-discriminatory access to the transmission system and the safe and reliable provision of transmission services. This chapter, therefore, sets out the obligations and responsibilities of the TSO and users in relation to the supply of data and information to each other, and also lists the various categories of data and information to be exchanged between the TSO and the users.

The data which is specified in different parts of the Grid Code are collated here in this Part VI. The relevant parts also specify the procedures and timings for the supply of the requisite data.

The various parts of the Grid Code also specify the information that the TSO will supply to users. This information is summarized in a single schedule in this Part VI.

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

In the event of any inconsistency between any other chapter of the Grid Code and Part VI "Data and Information Exchange Code", the provisions of that Part VI of the Grid Code shall prevail.

## 8.3 OBJECTIVES

The objective of this Part VI is to formalize the procedure for exchange of data and information between the TSO and users and to list the typical range of information and data that the users are required to submit to the TSO and the TSO is required to provide to the user(s) during the course of grid operation.

## 8.4 INTERVIEWS/MAPPING – DATA AND INFORMATION EXCHANGE CODE

*In the chapter "DATA AND INFORMATION CATEGORIES AND REGISTRATION" types of data for use in the communication are listed.*

*At the moment all communication of data besides the SCADA data communication, are made by telephone or paper.*

*Data archive are mostly made by paper. The SCADA system have an event log, failure log and some graphic presentation of measurements.*

*These data will disappear after some time unless they are stored manually in a longtime store.*

## 8.5 FINAL COMMENTS DATA AND INFORMATION EXCHANGE CODE

### 8.5.1 Gap between actual routines and the present Data and Information Exchange Code

This means that none of the assumptions set forward in the draft Grid Code are fulfilled.

As mentioned before the SCADA data communication are done by means of the PLC (power line carrier) system. When the ongoing commissioning of the OPGW grid is finished, there will be a possibility of fulfilling more of the features set forward in the draft Information Exchange Code.

The contractor of the SCADA system must take part in discussions with MOEP in order to create an archive systems based on the available data in the system.

Demand profiles and generation scheduling are impossible without available electronic communication. Dispatch planning as well.

Maintenance procedures should be made and statistic information is required to be able to make the right decisions and create the maintenance activities at the right time.

# 9 Metering Code

## 9.1 TABLE OF CONTENTS FOR THE DRAFT METERING CODE

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4. METERING EQUIPMENT ........ 4
5. METERING POINT ........ 4
6. METERING PARAMETERS ........ 4
7. METERING DATA STORAGE AND AVAILABILITY ........ 4
8. METERING EQUIPMENT STANDARDS ........ 6
9. TESTING AND INSPECTION OF METERING INSTALLATIONS ........ 7
10. MAIN AND CHECK METERING ........ 8
11. TIMEKEEPING ........ 8
12. METERING ACCESS AND SEALING ........ 9
13. REPAIR AND MAINTENANCE OF METERING EQUIPMENT ........ 9
14. APPROVAL, CERTIFICATION, AND TESTING OF METERING EQUIPMENT ........ 9
15. METER RECONCILIATION ........ 10

## 9.2 INTRODUCTION

In order to properly account for the flow of electricity through the transmission system, it is imperative that suitable and accurate metering and recording facilities are provided at all connection points on the grid. This Part VII “Metering Code”, therefore, deals with metering and recording requirements for participants and clarifies on their obligations relating to such installations. It also sets the minimum technical, design and operational criteria to be complied with by users relating to metering and data collection equipment and installations.

The provisions of this Part VII are specifically applicable to issues relating to the following:

(i) supply, installation, and maintenance of metering equipment (main as well as check) and their testing and calibration;

(ii) collection, storage, and communication of metering data; and

(iii) competencies and standards of performance of participants relating to metering.

## 9.3 OBJECTIVE

The objective is to set out the responsibilities of the participants relating to measuring and recording of active and reactive power flows and energy imports into or exports out of the grid and also to specify the terms and conditions that will govern the metering and recording equipment and systems employed for the above purpose.

## 9.4 INTERVIEWS/MAPPING – METERING CODE

All the substations have the meters read manual by the local staff and readings are transferred verbally by telephone to the head office in MOEP.

Meters are maintained by the office in Yangon.

The strategy and meter numbering in order to have a proper control of where and when the meters are commissioned are part of the job of the office in Yangon.

Distribution meters are read by metermen every month and data are punched into the billing system.

## 9.5 FINAL COMMENTS METERING CODE

### *9.5.1 Gap between actual routines and the present Metering Code.*

All the substations meters must have electronic communication in order to be in accordance with the draft Grid Code.

The strategy and meter numbering in order to have a proper control of where and when the meters are commissioned seems to be ok.

Meter communication standards for telemetric receiving from remote substations to EPGE should be implemented, e.g. the EDIEL standard.

The total metering system should be quality checked, calibrated and approved by a 3. party independent certified company in order to provide 100% reliable bills.

# 10 Main findings

- Quality control/finishing of commissioning are not satisfied.
  - Wiring in substations
  - Earth connections and earth wiring documentation
  - Finishing control of powerline commissioning.
- Relay and relay schemes probably big deficiency.
- No preventive maintenance routines.
- Redundancy in some important substations not available.
- Code for cable laying not present.
- Oil sumps for many big transformers not present.
- Switchyard in Yeyewa power plant could break down at any time. This will cause a severe blackout for the main grid.
- SCADA system have
  - not sufficient communication
  - datatesting not finished.
  - labelling strategy of elements not sufficient. Possibility of switching failure.
  - remote operation routines from control centre not implemented.
  - maintenance of system routines due to change in grid not satisfactory.

# 11 Suggestion for implementation of Grid Code

A short presentation of a suggestion for further work was presented for relevant staff in MOEP on 14th of October 2015. We presented some suggestions for the stepwise introduction of a Grid Code by establishing an internal process in the organisation.

We stated that MOEP are very busy with ongoing projects for new plants, but some work have to be done in order to improve actual Grid Code.

The suggestion is based on a bottom – up process in the organisation. This process starts with the establishment of the actual organisation dealing with different parts of Grid Code. By doing this in a process-oriented way, the implemented staff starts thinking of how to cooperate when they are working with the high voltage installations and operation. This means existing, planned as well as new installations.

## 11.1 GRID CODE

A Grid Code is a technical specification, which defines the parameters a facility connected to a public electric network has to meet in order to ensure a safe, secure and economic proper functioning of the electric system.

The facility can be an electricity generating plant, a consumer, or another network.

The Grid Code is specified by the authority responsible for the system integrity and network operation and usually involves the network operators (DSO or TSO), representatives of users and, to an extent varying between countries, the regulating body.

The Grid Code objective must be to Issue and maintain a guideline for the national high voltage transmission grid in order to continuously serve the customers in Myanmar with the promised and expected quality of electricity supply. And to improve the reliability of the electricity supply in Myanmar.

Grid code strategy might be to create an atmosphere of loyalty and ownership to the Grid Code within the organisation by means of continuous training and involvement of the staff. This will get all parts of the organisation to understand the importance of the Grid Code and to work for the same objectives.

The staff will always know about weak points and suggest how things can be improved.

Internal workshops with participants from different parts of the organisation can initiate small adjustments to the Grid Code that can represent the difference between outage or no-outage in the grid.

Keep an open dialogue with MOEP power plants as well as the IPP's, DSO (YESC and MESC), consumers, and other networks to get feedback in order to improve and keep the Grid Code up-to-date.

Revise/adjust the Grid Code continuously and support an online version with half-yearly updates of critical parameters. Official release e.g. every 2nd year.

It is important to state the fact that Grid Code will never be a finished work. Increased demand for electricity will always claim better quality.

## 11.2 PROCESS ORGANISATION DEALING WITH GRID CODE

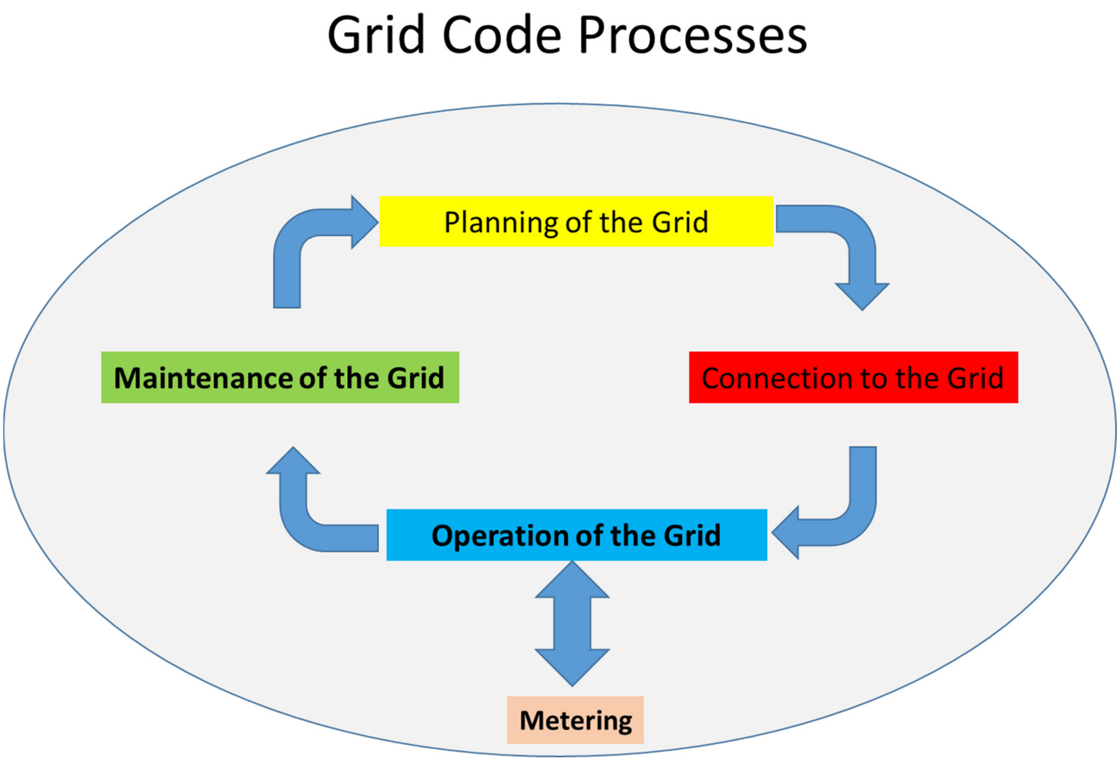
By giving priority to the most important parts from the beginning we suggest to deal with:

- Planning
- Connection
- Operation
- Maintenance
- Metering

These operations are parts of the current organisation, but we find the interaction to be very weak.

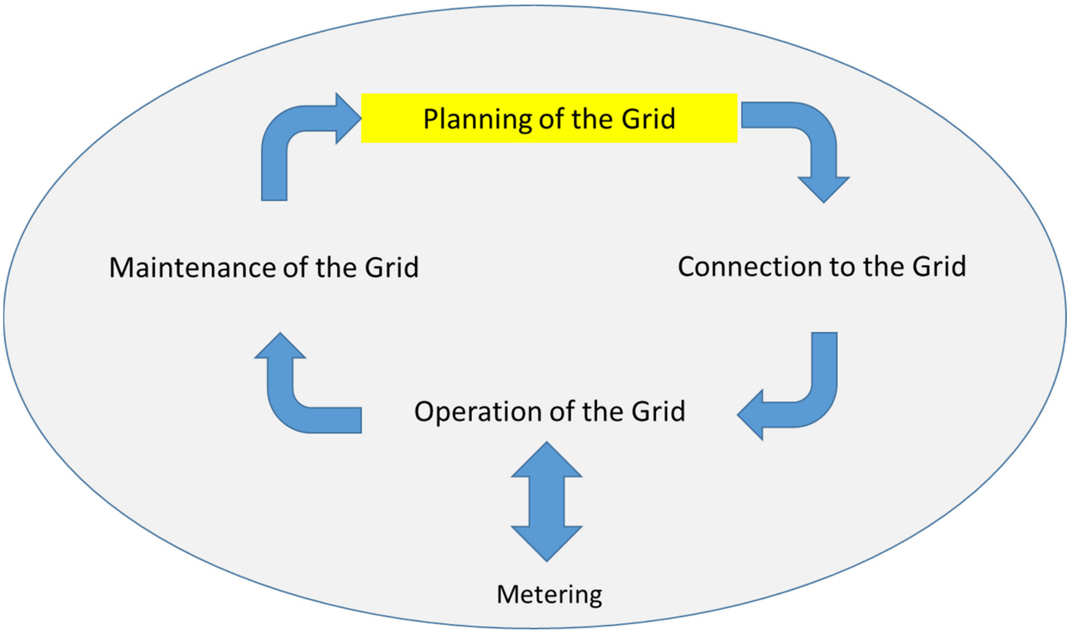
To visualise the thinking the interaction can be compared with a continuously rotating wheel.

The figure below is used to visualise this.



### *11.2.1 Planning*

Actions suggested as a start for the planning group.





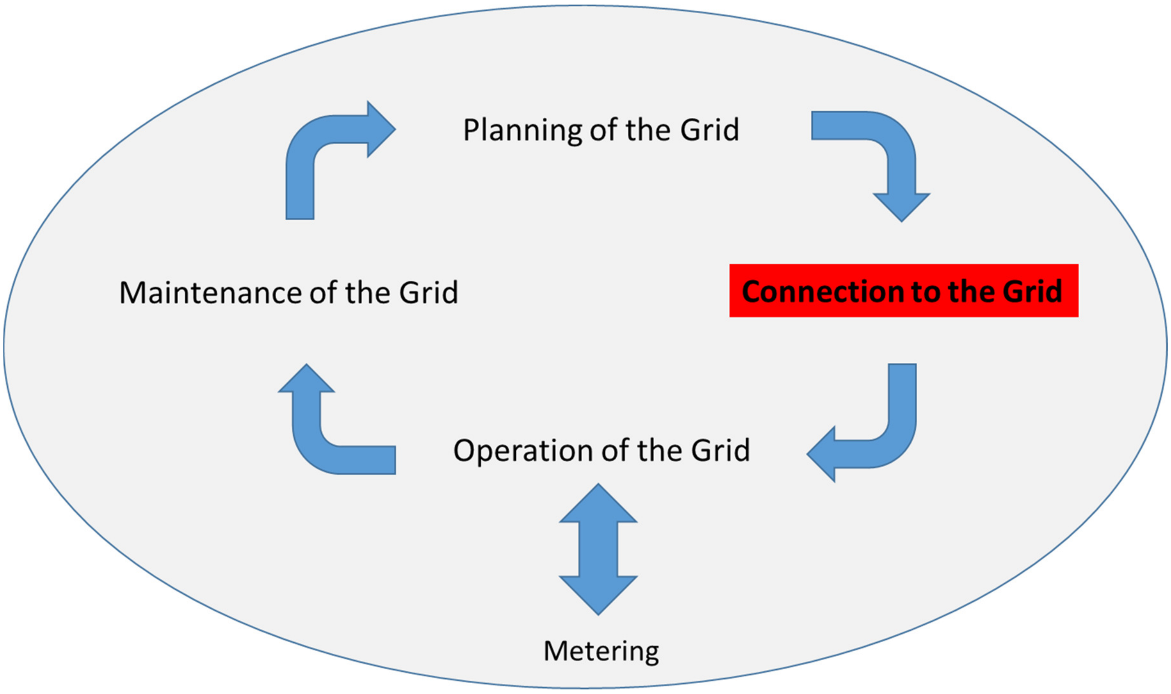
Planning Data:
- Historical Energy and Demand
- Energy and Demand Forecast
- Generating Unit projects Station Data
- User System Data

Grid planning studies periodically
- load flow studies,
- short-circuit studies,
- transient stability studies,
- steady state stability studies,
- voltage stability studies,
- electromagnetic transient studies,
- reliability studies

Result:
- New or change in grid
- Uprating existing grid capacity
- New substations
- New protection installations
- New communication/SCADA
- Better AVC (voltage control)
- Uprating components due to short circuit level in grid.

### *11.2.2 Connection*

Actions suggested as a start for the organisation dealing with new connections.





Connection Data:

- Frequency range
- Harmonic distortion (power electronic)
- Phase unbalance
- Voltage Fluctuation and Flicker Severity
- Transient Voltage Variations
- Earthing
- Data of connected Switchgear
- Data of connected Generators
- Single line diagram
- Relay and relay schemes

Evaluate an give permission to connection:

- connection agreement discussions with customer
- consider data of equipment
- consider grid safety and voltage stability
- consider test procedure of new equipment
- Generators:
  - Power factor
  - generating unit under steady state conditions (normal voltage in the normal operating rangechange)
  - Black start capability

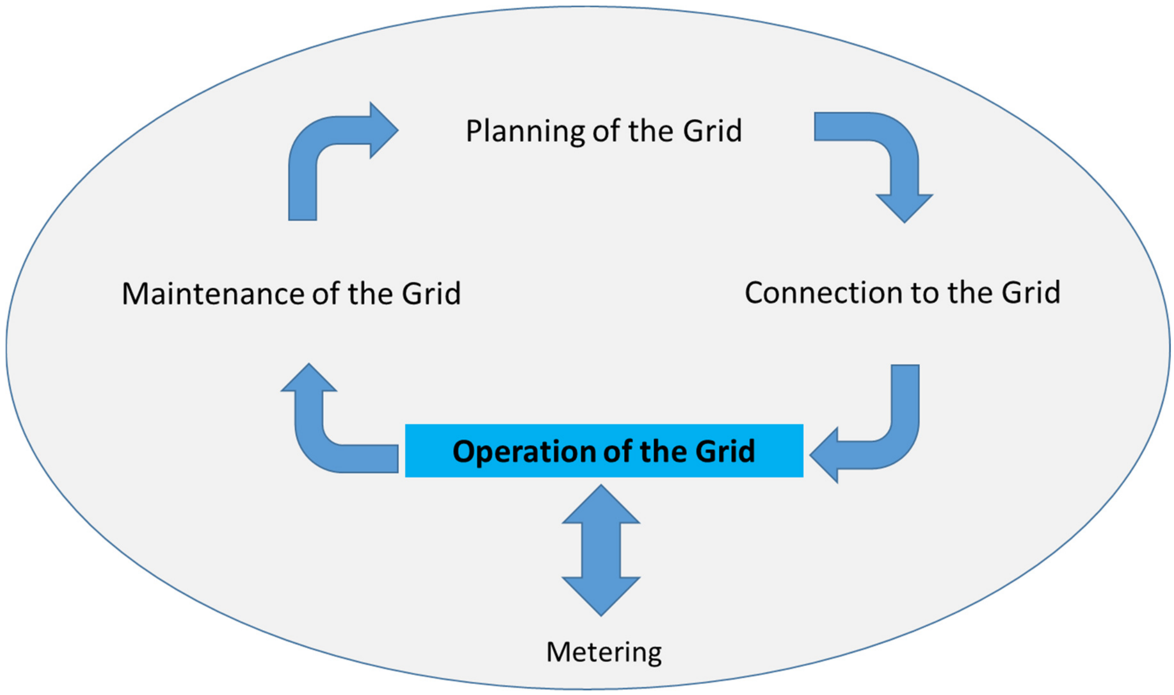
Checkout with the planning team.

Result:

- Connection agreement
- Responsibility for operation and Maintenance
- Responsibility for safety
- Connection point single line diagram
- Maintenance procedures
- SCADA connection
- Relay testing
- SAT testing control system data

### *11.2.3 Operation*

Actions suggested as a start for the the operation group.





Operation Data:

- Delivery quality (promised)
- Forecast
- Outage need from maintenance/outage planning
- Contingency planning
    - In emergency situations
    - include generators providing black start capability
- Correct and reliable remote control input from the substations. (Measuring, relay signals, event logging)

Operation:

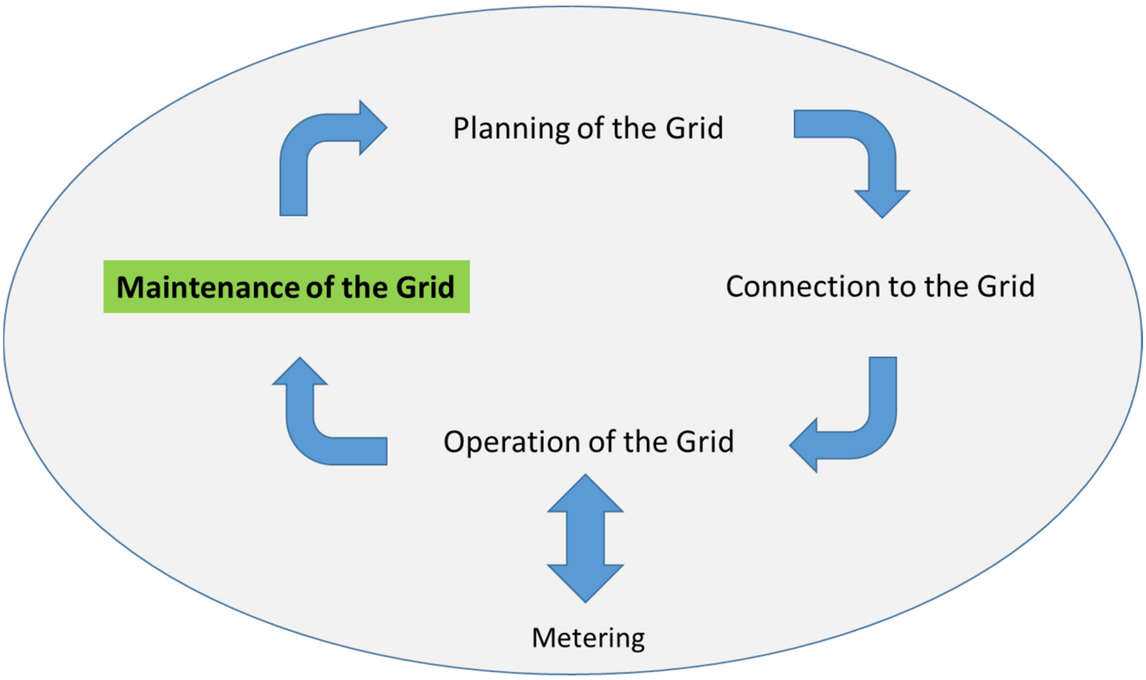
- System service
    - frequency control
    - voltage control
    - system control
    - generation dispatch control
    - operating margin
- Responding to emergency and fault situations on the Transmission System
- Execute Black start coordination
- Training of the staff to deal with failure and outage situations.
- Consider available swing machine availability to secure the grid security (AVC)

Result:

- Fulfil promised quality to the grid user at any time
- Fulfil the need of energy to the user.
- Correct metering data to the invoice office
- Fault reports to planning and maintenance.

### *11.2.4 Maintenance*

Actions suggested as a start for the maintenance group.





Maintenance Data:

- Fault and unexpected outage reports from Operation
- Relay failure reports
- Power line breakdown or component failure
- Substation failure
- Earthing problems
- Reports from site inspection staff
- Switchgear status and failure reports from power generating office.
- List of needed preventive maintenance
- Updated single line diagrams
- Reports of needed maintenance of telecommunication equipment.

Evaluate the input continuously:

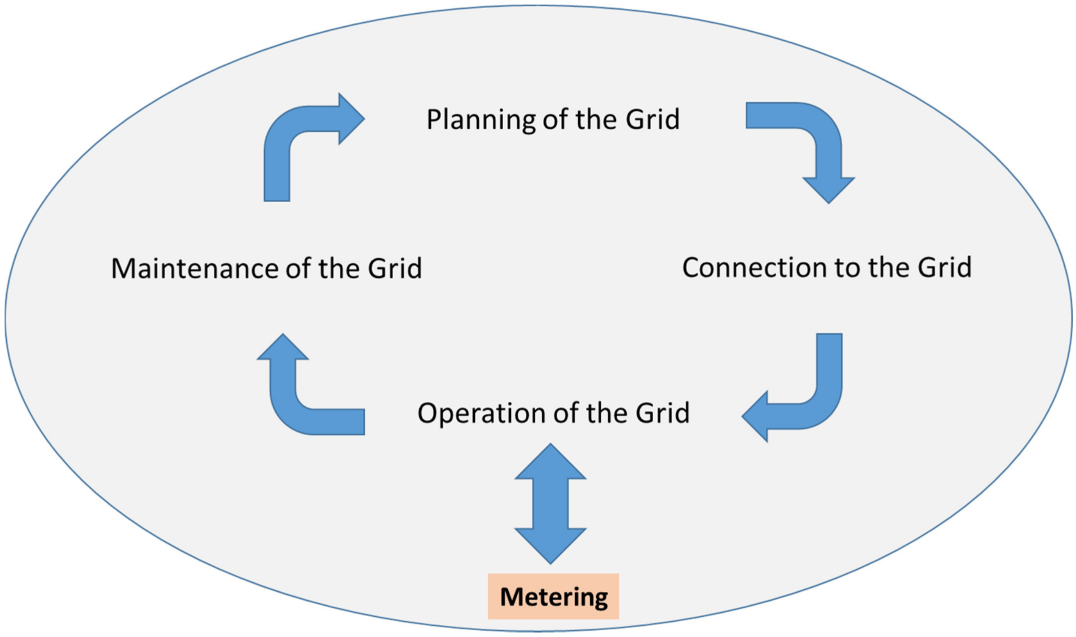
- need for immediate repair
- program for weekly, monthly and yearly maintenance
- meeting with planning and operation
  - in order to avoid unnecessary outage
  - consider grid safety and voltage stability
- consider test procedure for equipment with unstable functionality
- Relay testing program and revision of relay schemes
- Evaluation of every unexpected outage.

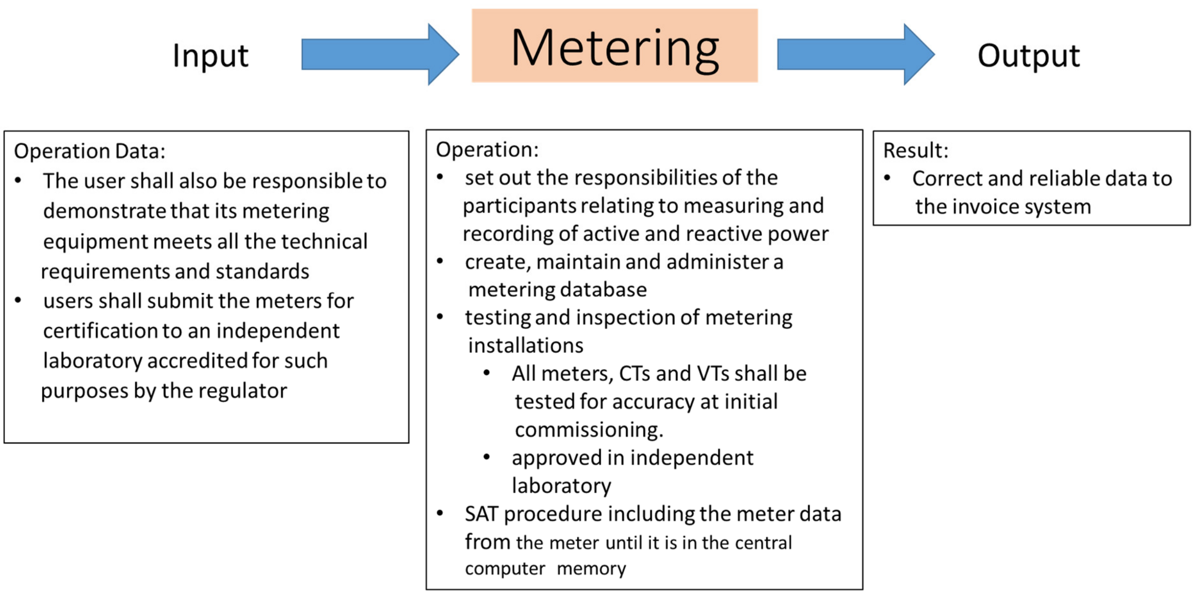
Result:

- Short- and long-term maintenance programs
- Need of staff for the immediate or planned maintenance activity
- Bidding documents for long-term maintenance jobs
- Preliminary change in single line diagram as part of preliminary maintenance outage
- Procedures together with operation in connecting with necessary switching and earthing of grid during maintenance operations
- Relay testing plan.
- Need of more training of staff?
- HSE plan (Health, Safety and Environment) for staff.

### *11.2.5 Metering*

Actions suggested as a start for the metering group.



## 11.3 SUGGESTION FOR FOLLOW-UP WORK

By involving the staff in a process where they know how to deal with the items and issues, an atmosphere of enthusiasm for the objective as well as ownership will arise. However, in order for this to happen it is important initially to make it simple and point out the most important parts.

Without this thinking we do not think the contents of the present reports will be realised.

Action:

- The described method must have a solid “anchoring” at top level in MOEP.
- The leaders of different parts of the actual staff must come together and plan the process.
- The different leaders must point out a person in his staff to take part, and be responsible for the continuity in the education process.
- NVE must develop the start program and see to the continuity in the process.
- 2 – 4 years with workshops from time to time to check the progress and give guidance and new task.