ENERGY
REGULATION
BOARD

ZAMBIAN DISTRIBUTION GRID CODE

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ACKNOWLEDGEMENTS

This is the first issue of the Zambian Distribution Grid Code. The development of the Distribution Grid Code has been accomplished by the extensive efforts of the Energy Regulation Board (ERB) and was subjected to broad technical and legal reviews by stakeholders in the Zambian Electricity Supply Industry (ESI).

This Distribution Grid Code, although uniquely Zambian, has drawn on the following internationally available grid codes and documents:

a). The South African Renewable Energy Code
b). The South African Distribution Code
c). The Zimbabwe Distribution Code
d). The Namibian Net Metering Rules
e). The Zimbabwean Solar PV Integration Code
f). Guidelines for embedded generator connection to Australia Gas Light Company (ActewAGL)'s low voltage (LV) network
g). Relevant Zambian Standards
h). Germany Technical Guideline for Generating Plants (BDEW June 2008) connected to the Medium- Voltage Network

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FOREWORD

It is with great pleasure that I present the first issue of the Zambia Distribution Grid Code ("Distribution Code"). The Distribution Code is designed to provide clear procedures for both planning and operational purposes to ensure efficient development, operation and maintenance of a co-ordinated and economical distribution system and also to promote grid integration of renewable energy technologies. The Distribution Code seeks to avoid undue discrimination between Distribution Network Service Providers (DNSPs) and other categories of participants.

It is gratifying to note that the development of the Distribution Code has been accomplished by the extensive efforts of the Energy Regulation Board (ERB) and was subjected to review by key stakeholders in the Zambian Electricity Supply Industry (ESI). This collaboration demonstrated amongst the stakeholders during the development of the Code is commendable, and it gives me great comfort that this will translate into the smooth implementation of this Code.

The Code is coming at an opportune time to provide a framework for addressing some of the challenges being faced in the distribution network arising from various developments in the ESI. Some of these developments have included the deployment of distributed generators connecting directly into the distribution network, integration of renewable energy based generation into the distribution network and net metering to allow domestic customers with renewable energy based generation to supply part of their generation into the distribution network.

The Code is a live document and may, from time to time, change to reflect stages of development of the ESI and to comply with legislation and good industry practice.

I am confident that the implementation of the Distribution Code will further complement the Government's efforts to ensure the provision of reliable and quality energy services to end- use customers.

Professor Francis Davison Yamba
VICE- BOARD CHAIRMAN

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ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
AMR	Automated Meter Reading
CT	Current Transformer
DC	Direct Current
DGCRP	Distribution Grid Code Review Panel
DNSP	Distribution Network Service Provider
DSM	Demand Side Management
DS	Distribution System
EHV	Extra High Voltage
ERB	Energy Regulation Board
ESI	Electricity Supply Industry
HV	High Voltage
Hz	Hertz
IPS	Interconnected Power System
LV	Low Voltage
MEWD	Ministry of Energy and Water Development
MV	Medium Voltage
MVA	Mega-Volt-Ampere
MVAr	Mega-Volt-Ampere reactive
MW	Mega-Watt
NEP	National Energy Policy
OLTC	On-Load Tap Changing
OPPPI	Office for Promoting Private Power Investment
POC	Point of Connection
PSDMP	Power System Development Master Plan
PV	Photovoltaic
REA	Rural Electrification Authority

REMP	Rural Electrification Master Plan
RPP	Renewable Power Plants
SAPP	Southern African Power Pool
SCADA	Supervisory Control and Data Acquisition
SO	System Operator
SRI	Small Renewable In-feed
TNSP	Transmission Network Service-Provider
TOU	Time-Of-Use
TSO	Transmission System Operator
TS	Transmission System
TX	Transformer
VT	Voltage Transformer
ZABS	Zambia Bureau of Standards
ZDA	Zambia Development Agency
ZEMA	Zambia Environmental Management Agency
ZS	Zambian Standard

DEFINITIONS

Avoided costs

Avoided cost is the marginal cost for the same amount of energy acquired through another means such as construction of a new production facility or purchase from an alternate supplier

Code

The Zambia Distribution Grid Code

Connection Agreement

An agreement between *DNSP*(s) and each *Customer* setting out terms relating to a connection with the *Distribution System*

Connection charge

A charge recouped from the customer for the cost of providing new or additional capacity (irrespective of whether new investment is required or not). This is recovered in addition to the tariff charges as an up-front payment (connection fee) or as a monthly charge where the distributor finances the connection

Customer

A *person or entity* whose premises are connected or has applied to have premises connected to the *Distribution System* for the purpose of obtaining interconnection of its premises to the Distribution System

Customer Asset

Electrical assets that are owned by the *customer* and are designed and installed in accordance with Zambia Wiring of Premises standard, ZS 791

Customer Interruption Cost

This is the cost to customers due to interruptions of supply (cost of unserved energy)

Dedicated Assets / Dedicated Network

The portions of the network which are dedicated to a specific *customer* - *Customer* dedicated assets are assets created for the sole use of a *customer* to meet the customer's technical specifications, and are unlikely to be shared in the *DNSP*'s planning horizon by any other end-use *customer*

Demand

The electrical power which is drawn from the system by a *Customer*, usually expressed in MW, MVA or MVAr

Demand Side Management (DSM)

Technologies or programmes that encourage customers to modify their patterns of electricity usage including timing and level of consumption; this includes conservation, interruptability and load shifting

Distribution charges

The grouping of the *Distribution Use of System* (DUoS) charges and the connection charge

Distribution System

The network owned or operated by a *DNSP*

Distribution Network Service Provider (DNSP)

A *licensee* that owns and maintains a network on the *Distribution System* (or has such right by virtue of its historic existence for this purpose)

Distribution System Voltage

The set of nominal voltages that are used in power systems for distribution of electricity and whose upper limit is generally accepted to be 66 kV

Distribution System Impact Assessment Studies

Studies to model and assess the impact of connecting a *customer* load or an *embedded generator* on the *Distribution System*

Distribution Use of System (DUoS) charges

Unbundled regulated tariffs charged by the *DNSP* to the distribution network services customers for making capacity available and for use of the *distribution system*

Domestic supply

Supply taken by a customer occupying a residential dwelling

Earthing

The provision of a connection between conductors and earth by means of an Earthing Device

Earthing Device

A means of providing a connection between a conductor and earth of adequate strength and capability for its intended purpose

Economic Cost

Total cost of the electricity related investment to both the *DNSP* and the *customer*(s)

Economic evaluation

The project benefits and returns including both the *DNSP*'s and the affected *customer*'s costs related to electricity infrastructure

Embedded Generation

Generation units connected within a distribution network and not having direct access to the transmission network

Embedded Generator

A Licensee, who owns, operates or controls an embedded generation unit

End-use customer

Users of electricity connected to the Distribution System

Energy charges

Charges designed to recover the costs of electrical energy

Energy Regulation Board (ERB)

A statutory body established by the Energy Regulation Act Cap. 436 of the Laws of Zambia, to regulate the energy sector in Zambia

Excess generation" or "net exports

Means that, in a month with regard to meter readings, a net metered customer is a net exporter of electricity to the *local distribution grid*

Excluded services

Services requested by customers that are excluded from the regulated activities and funded directly by the customer requesting the service

Extra High Voltage (EHV)

Nominal voltage levels greater than 220kV

Fault Level

The prospective current that would flow at a stated point on the system during a short-circuit. It is expressed in kA or in MVA

Firm supply

A Distribution supply that can withstand any single (n-1) contingency within the Distribution network, e.g. the customer supply shall not be dependent on any single component

Forced outages

Outages which occur when a component is taken out of service immediately, either automatically or as soon as switching operations can be performed as a direct result of abnormal operating/emergency conditions or human error

Fundamental Frequency

This is the operating or system frequency of the Power System. Parameters whose frequency is the same as the fundamental frequency are referred to as fundamental parameters

Generator

A *Licensee* that operates one or more units that supply power to the *Transmission System* or *Distribution system*

Harmonics

Sinusoidal currents with a frequency equal to an integer multiple of the fundamental frequency

High Voltage (HV)

Nominal voltage levels equal or greater than 33 kV up to and including 220kV

Information Owner

The party to whose system or installation the information pertains

International customers

Customers who are situated outside the borders of Zambia and supplied by the *DNSP* as defined in this *Code*

Interruption (of supply)

A phenomenon that occurs when one or more phases of a supply to a consumer/group of consumers are disconnected for a period exceeding 3s

Least-economic cost

The lowest value of the sum of the life cycle costs to both the *DNSP* and the *customer* related to various options for the supply of electricity

Least life cycle costs

The lowest sum of all cost categories from installation to decommissioning when evaluating the different investment alternatives for the supply of electricity

Licensee

A legal entity licensed by the ERB in terms of the Energy Regulation Act to provide the electricity distribution and/or trading services

Losses

Energy for which the *DNSP* does not recover revenue. Losses include *technical losses* and *non-technical losses*.

Low Voltage (LV)

Nominal voltage levels up to and including 1 kV as defined in ZS 387

Metering Installations

All meters, fittings, equipment, wiring and installations, used for measuring the flow of electricity

Metering service provider

A legal entity contracted by the *DNSP* to provide metering services.

Medium Voltage (MV)

Nominal voltage levels greater than 1 kV and less than 33kV as defined in ZS 387. The set of nominal voltage levels that lie above low voltage and below high voltage in the range 1 kV $< U_n \leq$ 33 kV

Micro-Embedded Generation Installation

For the purpose of this *Code* a micro embedded generator has a nameplate rating less than 2KVA

Mini –Embedded Generation Installation

For the purpose of this *Code,* a mini embedded generator has a nameplate rating greater than 2 kVA and up to 10 kVA single phase and 30 kVA three phase

Net Metering

A methodology under which electricity is generated on the *customer*'s side of the billing meter with renewable energy generation and delivered to an electricity distribution licensee's local distribution facilities that is primarily intended to offset part or all of the customer's electrical energy provided by the *DNSP* to the *customer* during an applicable billing period

Net-metering-customer

Any *customer* of a DNSP that generates electricity on the *customer*'s side of the billing meter with renewable energy generation that is primarily intended to offset part or all of the customer's electricity requirements

Network

Electrical infrastructure over which electrical energy is transported from source to point of consumption

Network stability

The ability of an electrical network to cope with changes in the operational conditions (such as prolonged over voltage, faults, switching large loads/generators on and off, lightning strikes, etc) Network instability may lead to the total loss of power to sections of, or the complete electrical network ("blackouts")

Non-technical losses

Losses due to theft of electrical energy and errors due to inaccuracy of meters and administrative losses

Parallel operation

The operation of embedded generation by a customer while the customer is connected to a DNSP's *system*

Point of connection

The electrical node on a distribution system where a customer's assets are physically connected to the DNSP's assets

Participant

Participants are:

a). DNSPs
b). Embedded Generators
c). End-use customers
d). Retailers
e). Regional Operator
f). TNSPs- Transmission Network System- Providers

Point of supply

Physical point on the electrical network where electricity is supplied to a customer

Prudent Utility Practice

Those standards, practices, methods and procedures that conform to safety and legal requirements which are attained by exercising that degree of skill, diligence, and foresight which would be reasonably and ordinarily be expected from skilled and experienced operatives engaged in the same type of undertaking under the same or similar circumstances

Resellers

An "unlicensed buyer of electricity from a licensed distributor for the purpose of selling it to the end users within the area of distribution of such DNSP at the approved tariff of such DNSP"

Regional Operator

An entity subordinate to the SO and independent from other market participants responsible for short-term reliability of the IPS, which is in charge of controlling and operating part of the system in real time

Small to Medium Scale Embedded Generation Installation

For the purpose of this *Code* a small scale embedded generator is up to a capacity of 1 MVA and a medium scale embedded generator is up to a capacity of 10 MVA.

This definition includes initiatives such as:

a). Synchronous generators driven by hydro turbines.

b). Synchronous generators driven by gas engines, gas turbines or diesel engines.

c). Inverter Energy Systems.

This does not include plant which is operated and connected in parallel with the network for the purpose of network or emergency support

System Operator

A *Licensee* responsible for short-term reliability of the Interconnected Power System (IPS), which is in charge of controlling and operating the transmission system (TS) and dispatching generation (or balancing the supply and demand) in real time.

Transmission System

The TS consists of that part of the IPS which supplies power in bulk from power stations to DNSPs and other customers and includes:

a). all transmission lines and substation equipment on the IPS where the nominal voltage is as defined in the ZS387 – 1: Power Quality and Reliability Standard;

b). all associated equipment at TNSP substations belonging to the TNSP.

Transmission Network Service-Provider (TNSP)

A *Licensee* that owns and maintains transmission equipment

User

A Customer or Embedded Generator

User Development

A participant's Plant and/or Apparatus and/or System to be connected to the Distribution System, or a modification relating to a User's Plant and/or Apparatus and/or System already connected to the Distribution System, or a proposed new connection or modification to the connection within the participant’s system

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1. INTRODUCTION

The National Energy Policy (NEP) seeks to promote optimal supply and utilization of energy, for socio-economic development in a safe and healthy environment. The policy sets out the Government's intentions aimed at ensuring that the energy sector's potential to drive economic growth and reduce poverty is harnessed.

The energy sector in Zambia is guided by the National Energy Policy which outlines the structure of the electricity subsector. The Ministry of Energy and Water Development (MEWD) is responsible for the development and implementation of the energy policy. The ministry fulfills its functions through the following statutory bodies; the ERB, OPPPI, REA, ZDA and ZEMA.

a). Energy Regulation Board (ERB):

The Energy Regulation Board (ERB) is a statutory body established by the Energy Regulation Act Cap. 436 of the Laws of Zambia, to regulate the energy sector in Zambia.

b). OPPPI

Office for Promoting Private Power Investment (OPPPI) is charged with the responsibility of siting generation projects above ten (10) Mega Watts for development.

c). REA

The Rural Electrification Authority (REA) is a statutory body created under the Rural Electrification Act No. 20 of 2003 of the Laws of Zambia.

d). ZDA

Zambia Development Agency (ZDA) is a statutory agency established through an Act of parliament No. 11 of 2006 to further the economic development in Zambia by promoting efficiency, investment and competitiveness in business and promoting exports from Zambia.

e). ZEMA

Zambia Environmental Management Agency (ZEMA) is an independent environmental regulator and coordinating agency, established through an Act of parliament No. 12 of 2011 to ensure the sustainable management of natural resources and protection of the environment, and the prevention and control of pollution.

1.1 Zambian Electricity Supply Industry

The Electricity Supply Industry (ESI) in Zambia comprises generation, transmission, distribution and supply of electrical energy.

1.1.1. Industry Structure

The current Electricity Supply Industry comprises the following utilities:

a). **ZESCO** - a state owned entity which is involved in generation, transmission, distribution and supply of electricity.

b). **CEC –** a privately owned company which is involved in the transmission and distribution of electricity to the mines and other customer categories.

c). **Lunsemfwa hydro power company (LHPC) –** a privately owned company which is involved in generation and transmission of electricity to the national grid.

d). d). **Zengamina Power Company (ZPC) –** a privately owned generation company operating an isolated grid which is involved in generation and distribution of electricity.

e). **North Western Energy Company (NWEC) –** a privately owned company involved in distribution and supply of electricity.

f). **Ndola Energy Company (NEC) –** a privately owned company in generation of electricity.

g). **Maamba Collieries Ltd (MCL) -** a privately owned company in generation of electricity.

h). **Itezhi-Tezhi Power Corporation –** Jointly owned company by Tata Power and ZESCO Limited in a 50:50 share ownership in generation of electricity.

i). **Kariba North Bank Extension –** a Special Purpose Vehicle (SPV) company wholly owned by ZESCO involved in generation of electricity.

j). **Other renewable sources of energy –** mainly those generating using renewable energy sources such as solar, wind, biomass, biogas and geothermal technologies.

1.1.2. The Distribution System

The distribution system in Zambia is categorized by voltage levels between 11kV and 66kV. The use of the Distribution System may involve any of the following transactions:

a). A connection at entry to or exit from the Distribution System - An entry point is the connection between the Distribution System and the Transmission System or a Generating Unit. An exit point is the connection between the Distribution System and the Customer's premises.

b). Use of the Distribution System to transport electricity between entry and exit points.

1.2 Purpose of Distribution Grid Code

The Distribution Grid Code is designed to permit the development, maintenance and operation of an efficient, coordinated and economical Distribution System and generally to provide a description of the technical connection requirements for large embedded generating systems from renewable energy. It is conceived as a statement of what is technically optimal for the DNSP and other participants in relation to the planning, operation and use of the Distribution System. It seeks to avoid any undue discrimination between DNSPs and other categories of participants.

The Distribution Grid Code is a document approved by the Energy Regulation Board (ERB) formulated in order to ensure efficient coordinated operation and maintenance of the electricity Distribution System. It shall be a document agreed upon and to be complied with by all participants. The Distribution Grid Code is a dynamic document that shall be revised periodically as per the procedures from time to time, taking into account the reasonable interests and views as expressed by the stakeholder entities in the light of the experience gained in the actual implementation of the Code.

1.3 Objectives of the Distribution Grid Code

The Distribution Grid Code establishes the basic rules, procedures, requirements and standards that govern the operation, maintenance, and development of the electricity Distribution Systems in Zambia to ensure the safe, reliable, and efficient operation of Distribution System.

The objective of the Distribution Grid Code is to promote sound planning, operational and connection standards in a bid to provide for reliable, secure, economic and coordinated operation of the Distribution System. This will be achieved through the following: -

a). Specification of minimum operational standards
b). Specification of minimum technical requirements
c). Specification of minimum safety and customer handling standards
d). Specification of information requirements and procedures
e). Specification of minimum requirements for embedded generators
f). Streamlining responsibilities and obligations for all the participants
g). Establishment of requirements for the development of the Distribution System

1.4 Content of the Distribution Grid Code

The Distribution Grid Code consists of the following chapters:

1.4.1. Distribution Network Chapter

a). Distribution System Connection Process and Procedure
b). Responsibilities of the participants
c). Distribution System Technical Requirements
d). Distribution System Planning and Development
e). Embedded Generators Connection Conditions
f). Power Station Supplies

1.4.2. Distribution System Operation Chapter

a). Operational Responsibilities of the participants
b). Operational Authority and Procedures
c). Operational Liaison
d). Emergency and Contingency Planning
e). Operation during Abnormal Conditions
f). Independent Actions by Participants
g). Demand and Voltage Control
h). Fault Reporting and Analysis/Incident Investigation
i). DNSP Maintenance Program
j). Testing and Monitoring
k). Safety Co-ordination
l). Disconnection and Reconnection
m). Outage scheduling and co-ordination
n). Tele-control

1.4.3. Distribution Metering Chapter

a). Application of the Metering Code
b). General Provisions
c). Metering requirements
d). Confidentiality of Metering Data
e). Customer queries on Metering integrity and Metering Data
f). Net metering aspects

1.4.4. Distribution Tariff Chapter

a). Principles for the determination of tariffs
b). Governance and communication process
c). Segmentation of costs for tariff design purposes
d). Cost reflective tariff structures
e). International load customers

f). Recovery of subsidies and other levies using tariff structures
g). Non-tariff costs (excluded services costs)
h). Connection charges
i). Financing of charges for excluded services and connection charges

1.4.5. Distribution Info Exchange Chapter

a). Information Exchange Interface
b). Provision and exchange of Information during the planning and connection process
c). Operational Information
d). Confidentiality of information

1.4.6. Grid Integration of Renewable Energy Based Power Plants

a). Grid Connection Requirements
b). Information Requirements

1.4.7. Distribution Governance Chapter

a). Implementation
b). Unforeseen Circumstances
c). Hierarchy
d). Distribution Grid Code Review Panel
e). Communications between the DNSP and other categories of participants
f). Emergency Situations
g). Code Responsibilities
h). Exemptions

2. NETWORK CHAPTER

2.1 Objectives

a). To set the basic rules of connecting to the *Distribution System*.
b). To ensure that all *participants* are treated in a non-discriminatory manner.
c). To specify the technical requirements to ensure the safety and reliability of the *Distribution System*.

2.2 Scope of Application

The Distribution Network Chapter shall apply to all Participants of the *Distribution System* including:

a). DNSPs
b). Embedded Generators
c). End-use customers
d). Retailers
e). TNSPs- Transmission Network System- Providers

2.3 Distribution System Connection Process and Procedure

2.3.1. Connection Agreement

2.3.1.1 Any *Customer* or Embedded Generator seeking a new connection to the Distribution System shall secure the required Connection Agreement with the DNSP prior to the actual connection to the Distribution System.

2.3.1.2 The DNSP shall develop application procedures for connection to the distribution system to be used by customers for application to be connected to the Distribution System. The application for connection procedures shall be approved by ERB.

2.3.1.3 A customer requiring new connection/alteration to existing supply shall provide all technical details requested by the DNSP to enable the DNSP to make a fair assessment of the customer's requirements.

2.3.1.4 Before the customer is physically connected, the DNSP shall satisfy itself that the installation is safe to be connected. These safety requirements shall be approved and monitored by ERB.

2.3.1.5 The DNSP shall issue a certificate of electrical safety to the customer for every installation established.

2.3.1.6 A connection agreement, detailing among others the contracted supply and applicable tariff, shall be drafted by the DNSP and signed by both DNSP and customer in respect of each and every connection/supply point.

2.3.1.7 A new connection to the distribution network shall be by means of a single or three phase overhead line with bare or insulated conductors, an underground cable or a combination of both in accordance with the Electricity (Supply) Regulations.

2.3.1.8 All equipment on the customer's installation shall be suitable for use at the operating frequency of 50 Hz and at the voltage and stipulated short-circuit rating and shall normally be controlled within the approved limits.

2.3.1.9 The DNSP shall require certification and evidence to conclusively prove that the equipment installed or to be installed has been designed, tested and installed in a satisfactory manner and in conformance with the relevant standards and this Code.

2.3.2. Application for Connection or Modification

Any Customer or Embedded Generator applying for connection or a modification of an existing connection to the Distribution System shall submit to the DNSP the completed application form for connection or modification of an existing connection to the Distribution System. The application form shall include the following information:

a). A description of the proposed connection or modification to an existing connection, which shall comprise the Customer Development at the Point of Connection;

b). The relevant Standard Planning Data as requested by the DNSP; and

c). The Completion Date of the proposed Customer Development.

2.3.3. Processing of Application

2.3.3.1. The DNSP shall establish the procedure for the processing of applications for connection or modification of an existing connection to the Distribution System.

2.3.3.2. The DNSP shall evaluate the impact of the proposed participants' development on the Distribution System.

2.3.3.3. After evaluating the application submitted by the participant, The DNSP shall inform the Customer whether the proposed development is acceptable or not.

2.3.3.4. If the application of the customer is acceptable, the DNSP and the customer shall sign a Connection Agreement or an Amended Connection Agreement, as the case may be.

2.3.3.5. If the application of the Customer is not acceptable, The DNSP shall notify the Customer why its application is not acceptable.

2.3.3.6. The Customer shall accept the proposal of The DNSP within 30 days, or a longer period specified in The DNSP's proposal, after which the proposal automatically lapses.

2.3.3.7. The acceptance by the Customer of The DNSP's proposal shall lead to the signing of a Connection Agreement or an Amended Connection Agreement.

2.3.3.8. If the DNSP and the Customer cannot reach agreement on the proposed connection or modification to an existing connection, the DNSP or the customer may bring the matter before the ERB for resolution.

2.3.3.9. The DNSP shall use best endeavours to connect the customer on the date agreed with the customer.

2.3.4. Submittals Prior to the Commissioning

The following shall be submitted to the DNSP by the Customer or Embedded Generator prior to the commissioning date, pursuant to the terms and conditions and schedules specified in the Connection Agreement:

a). Specifications of major Customer Assets not included in the Standard Planning Data and Detailed Planning Data;

b). Details of the protection arrangements and settings for Embedded Generating Units and for other Customer;

c). Information to enable the DNSP to prepare the Fixed Asset Boundary

d). Electrical Diagrams of the Customer Assets at the Point of Connection;

e). Information that will enable the DNSP to prepare the Point of Connection Drawings;

f). A list of the names and telephone numbers of authorized representatives, including the confirmation that they are fully authorized to make binding decisions on behalf of the Customer

g). Proof of ownership of premises or lease agreement

2.3.5. Commissioning of Equipment and Physical Connection to the Distribution System

2.3.5.1. The Customer or Embedded Generator shall submit to the DNSP a written notice of readiness to connect.

2.3.5.2. Upon completion of the User Development, including work at the Point Of Connection, the Customer Assets at the Point Of connection and the User Development shall be subjected to the Test and Commissioning procedure as set by the DNSP

2.3.5.3. Upon acceptance of the customer's written notice of readiness to connect, the DNSP shall, within 15 days, issue a certificate of approval to connect.

2.3.5.4. The physical connection to the Distribution System shall be made only after the DNSP has issued the certificate of approval to connect to the User.

2.3.6. Connection Agreement for modification of existing connections

2.3.6.1. Any customer seeking to modify an existing connection to the Distribution System shall secure the required Connection Agreement with the DNSP prior to the actual modification.

2.3.6.2. Any alteration (be it temporary or permanent) to an existing installation shall not be made without approval from the DNSP.

2.3.6.3. The Connection Agreement shall include provisions for the submission of additional information required by the DNSP

2.3.7. Conditions for Disconnection of Supply

Embedded Generation and Customer Assets may be disconnected for the following reasons:

a). On customer's written request
b). In cases of emergency
c). In the event of violation of electricity safety regulations
d). In the event of violation of commercial agreements such as follows:

i). The supply of electricity to a customer's electrical installation is used other than at the customer's premises;

ii). A customer takes at the customer's supply address electricity supplied to another supply address;

iii). A customer tampers with, or permits tampering with, the meter or associated equipment; or

iv). A customer allows electricity supplied to the customer's supply address to bypass the meter.

v). Failure by customer to comply to any provision of this Distribution Grid Code

2.3.8. Conditions for Reconnection of Supply after disconnection

Subsequent to the disconnection under 2.3.7 an embedded generation and customer asset may be reconnected for the following reasons:

a). On customer's written request

b). Compliance with relevant electricity supply regulations where a disconnection was effected.
c). Compliance with relevant commercial terms and agreements.
d). In compliance with the regulatory order saved for technical or safety reasons

2.3.9. Distribution Load Flow Studies

2.3.9.1. The DNSP shall take all necessary measures to ensure that any proposed connection or modification of an existing connection to the Distribution System shall not result in the degradation of the quality of supply and service.

2.3.9.2. The DNSP shall conduct Distribution Load Flow Studies to evaluate the impact of the proposed connection or modification to an existing connection on the Distribution System. The evaluation shall include the following:

a). Impact of short circuit in-feed to the Distribution Equipment;
b). Coordination of protection system; and
c). Impact of User Development on power quality
d). Impact of User Development on the environment

2.3.9.3. The DNSP may disapprove an application for connection or a modification of an existing connection to the Distribution System if it is determined through the Distribution Impact Studies that the proposed connection or modification will result in the degradation of the quality of supply and service.

2.4 Responsibilities of the DNSPs

2.4.1. The *DNSP* shall make capacity available on its networks and provide open and non-discriminatory access for the use of this capacity to all *customers* including *Embedded Generators*. In exchange for this service, the *DNSP* is entitled to a fair compensation through electricity tariffs as described in the Tariff Chapter.

2.4.2. Each *DNSP* shall make available to the *customers* the Customer Connection Information Guide.

This guide shall cover as a minimum:

a). Process to follow when applying for supply at the specific DNSP
b). Information requirements of the *DNSP* from the *customer* to effect an appropriate connection.
c). Process and related timeframes which follow the application.

2.4.3. The DNSP shall respond to the customer’s request to connect within the period specified in ZS 397.

2.4.4. The DNSP shall enter into a connection agreement with the customer prior to the actual connection

2.4.5. The DNSP shall advise potential users of the expected reliability of its network.

2.4.6. The DNSP may participate in the final inspection and testing of customer equipment and facilities to be connected to its network.

2.4.7. The DNSP shall maintain its DS in accordance with prudent industry practice.

2.4.8. The DNSP shall be responsible for the planning, design and engineering specifications of the work required for the distribution system connection or expansion.

2.4.9. The DNSP shall conduct Distribution System Impact Assessment studies to evaluate the impact of additional large loads, connection of embedded generation or major modification to the Distribution System. The assessment conducted shall include the following:

a). Voltage impact studies
b). Impact on network loading
c). Fault currents
d). Coordination of protection systems
e). Impact on the system's *quality of supply*
f). Line or equipment upgrades

2.4.10. Network augmentation may be required at the cost of the customer when the connection of the embedded generator causes any of the following to occur:

a). Insufficient thermal capacity;
b). Prospective fault levels exceed the DNSP network's safe operating levels;
c). Network voltage limits are breached;
d). Network protection systems unable to detect all credible fault types;
e). Quality of supply limits are breached; and
g). Remote monitoring and control is required to be installed by the DNSP.

2.4.11. The DNSP is entitled to recover its costs for undertaking investigations in response to generation or load connection enquiries and processing an Application for a Connection Service.

2.4.12. The DNSP shall refuse to connect any facility which the Distribution Impact Assessment studies indicate will have a deleterious effect, exceeding the parameters laid down in the ZS387 and the ERB Power Quality Directive, when connected to the network.

2.4.13. The DNSP may request the customer to submit design information, drawings or other relevant information to the DNSP if the DNSP believes any proposed installation or modification has the potential to adversely or materially affect the performance of the Distribution System.

2.4.14. Should the results of the Distribution System Impact Assessment Studies of proposed new or altered equipment owned, operated or controlled by the DNSP or another customer indicate that there will be a physical effect at the point of connection; the DNSP shall notify all affected customers prior to commissioning.

2.4.15. The DNSP shall provide on request of a customer, design information, drawings or other relevant information of the present or proposed Distribution installation.

2.4.16. The DNSP shall connect the Embedded Generator in accordance with the requirements of section 2.7 of this code.

2.4.17. The DNSP employees or his agent entering the customer premises shall comply with the requirements of ZS 418.

2.5 Responsibilities of customers and /or users

2.5.1. The *Customer(s)* shall provide safe access to the *DNSP* employees to carry out the installation, operation, inspection and maintenance of the *DNSP*'s electrical equipment on the *customer*'s premises.

2.5.2. Customers shall ensure that there is no unreasonable delay to access to the DNSP's equipment.

2.5.3. Customers shall be responsible for the removal and the reinstallation of any Customer Asset for the DNSP to perform the installation work that the customer has requested.

2.5.4. Customers shall, prior to commissioning, attempt to identify if new or altered Customer Assets could have a deleterious effect at the point of connection. The customer shall advise the DNSP should such deleterious effect be identified.

2.5.5. Where the customer believes the present, or proposed DNSP installation has the potential to adversely or materially affect the performance of the customer Assets, the customer may request the DNSP to submit design information, drawings or other relevant information.

2.5.6. In addition, Customers shall comply with the reasonable additional requirements specified by the relevant DNSP in respect of the technical and design requirements of equipment proposed to be connected to the Distribution System.

2.6 Distribution System Technical Requirements

2.6.1. Protection requirements

2.6.1.1. The *DNSP*'s protection system shall be appropriately designed and maintained to ensure optimal discrimination, safety and minimum interruptions to *customers*.

2.6.1.2. The customer shall install and maintain protection, which is compatible with the existing Distribution System protection. The customer's protection settings shall ensure coordination with the DNSP's protection.

2.6.1.3. The customer shall provide the DNSP with test certificates, prior to commissioning, of the protection system/s that are installed at the point of connection with the DNSP.

2.6.1.4. Participants' protection systems shall make provisions to safeguard their own equipment from faults or conditions that may occur at the point of connection including loss of one or two phases of the three phase supply and low/high voltages on the phases and any auto-reclosing or sequential switching features that may exist on the Distribution System.

2.6.1.5. Where equipment or protection schemes are shared, the participants shall provide the necessary equipment and interconnections to the equipment of the other party.

2.6.1.6. The protection functions are considered adequate when the protection relays perform correctly in terms of:

a). Reliability
b). Security
c). Speed of operation
d). Selectivity
e). Sensitivity

2.6.1.7. All Distribution System users shall ensure correct and appropriate settings of protection to achieve effective isolation of faulty equipment within the specified clearance time. Protection settings at the Point Of Connection shall not be altered, or protection bypassed and/or disconnected without consultation and agreement of the DNSP and the User. In the case where protection is bypassed and/or disconnected, by agreement, then the cause must be rectified and the protection restored to normal condition as quickly as possible. If agreement has not been reached the electrical equipment will be removed from service forthwith.

2.6.1.8. The ERB shall monitor compliance to all matters covered by this section of the Code and shall design and effect appropriate penalties for enforcing compliance.

2.6.1.9. Testing of Protection Equipment

2.6.1.9.1. Each Distribution System User is responsible for tests on own equipment and a record of test results shall be kept for submission upon demand by the other users or the ERB or both. Additionally records of protection test results of the users own equipment must be submitted to the DNSP. Periodic tests must be performed once every two years.

2.6.2. Earthing Requirements for Substations

2.6.2.1. Earthing Systems

2.6.2.1.1. All substations earthing systems should have earth resistance lower than 10 ohms for effective discharge of lightning or over voltages to earth.

2.6.2.1.2. The current carrying paths of an earthing system should have enough capacity to deal with maximum fault current

2.6.2.1.3. Earthing Mat shall be provided below ground level and earth electrodes shall be driven into ground at several points and shall be connected to the Earthing Mat to form an Earthing Mesh.

2.6.2.1.4. All structures, transformer tanks, breakers, equipment panels shall be connected to this mat by copper conductor or galvanized steel strips.

2.6.2.1.5. Buried elements of the earthing system should be checked for condition at random points as and when necessary but not exceeding a period of five (5) years

2.6.2.2. Earthing Requirements

2.6.2.2.1. The *DNSP* shall advise *Users* about the neutral earthing methods used in the *Distribution System*.

2.6.2.2.2. The method of neutral earthing used on those portions of *User's* installations that are physically connected to the *Distribution System* shall comply with the DNSP*'s* applicable earthing standards as provided in ZS 418 and ZS 791 for loads and for embedded generators.

2.6.2.2.3. Protective earthing of equipment must be done in accordance with the applicable Zambian standard.

2.6.2.2.4. In cases where the calculated Ground Potential Rise exceeds 5kV, the responsible party shall inform the affected participants.

2.6.2.2.5. Approved designed lightning protection requirements shall be applied to the *Distribution System* and switching yards.

2.6.2.2.6. Substation earthing requirement shall be in accordance with ZS 418 and ZS 691.

2.6.3. Quality of Supply

2.6.3.1. The DNSP and other participants shall comply with ZS 387 and the ERB Power Quality Directive regarding the parameters listed below:

a). Voltage harmonics and inter-harmonics
b). Voltage flicker
c). Voltage unbalance
d). Voltage dips
e). Interruptions
f). Voltage regulation
g). Frequency
h). Voltage surges and switching disturbances

2.6.3.2. Special *quality of supply* criteria will be agreed between the *DNSP* and the *Embedded Generator and must meet the minimum requirements in the applicable Zambian Standards.*

2.6.4. Load Power Factor

2.6.4.1. Users, except for embedded generators, (with demand exceeding 100kVA) shall ensure that the power factor shall not be less than 0.92 lagging nor shall it go leading unless otherwise agreed to with the relevant DNSP.

2.6.4.2. Should the power factor go beyond these limits, participants shall take corrective action within a reasonable timeframe to remedy the situation. The ERB approved low power factor surcharge mechanism shall also apply.

2.6.4.3. The participant intending to install shunt capacitors or any other equipment for the purpose of complying with the power factor requirements shall inform the relevant DNSP.

2.6.5. Distribution Network Interruption Performance Indices

2.6.5.1. The ERB shall be responsible for setting the format in which the Distribution Reliability Indices are reported.

2.6.5.2. Before the end of each year the DNSP shall publish its targets for reliability of supply for the following year.

2.6.5.3. The ERB shall annually evaluate the Distribution System Reliability Indices to compare each DNSP's actual performance with the DNSP unique targets set by the ERB and the ERB shall publish these comparative results.

2.6.6. Losses in the Distribution System

2.6.6.1. System Loss shall be classified into two categories: Technical Loss and Non-Technical Loss, and Administrative Loss.

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

2.6.6.3. The Non-Technical Loss shall be the aggregate of the Energy lost due to pilferage, meter-reading errors, and meter tampering.

2.6.6.4. The Administrative Loss shall include the Energy that is required for the proper operation of the Distribution System and any unbilled Energy for community-related activities.

2.6.6.5. The DNSP shall identify and report separately to ERB the Technical and Non-Technical Losses in its Distribution System.

2.6.6.6. The ERB shall, after due notice and hearing, prescribe a cap on the System Loss that the DNSP can pass on to its End-Users. Separate caps shall be set for the Technical and Non-Technical Losses.

2.6.7. Equipment Requirements

2.6.7.1. Equipment at the point of connection shall comply with the national standards prevailing at the time.

2.6.7.2. The *DNSP* shall provide the *User* with the necessary information to enable the *User* to install equipment with the required rating and capacity.

2.6.7.3. The *participants* shall ensure that all equipment at the *point of connection* is maintained at least in accordance with the manufacturers' specifications or an alternate industry recognized methodology.

2.6.7.4. The *participants* connected at MV and HV/EHV levels shall retain the test results and maintenance records relating to the equipment at the *point of connection* and make this information available if requested

2.7 Embedded Generators Connection Conditions

2.7.1. Responsibilities of Embedded Generators to DNSPs

2.7.1.1. The *Embedded Generator* shall enter into a connection agreement with the *DNSP* before connecting to the *Distribution system.*

2.7.1.2. The *Embedded Generator* shall ensure that the reliability and *quality of supply* complies with the terms of the connection agreement.

2.7.1.3. The *Embedded Generator* shall comply with the *DNSP's* protection requirement guide detailed in this section as well as protection of own plant against abnormalities, which could arise on the *Distribution System*.

2.7.1.4. The *Embedded Generator* shall be responsible for any dedicated connection costs incurred on the Transmission System *or Distribution System* as a result of connection of the *Embedded Generation* facility to the *Distribution System* in compliance with the Tariff Chapter.

2.7.1.5. The *Embedded Generator* shall be responsible for synchronizing the generating facility to the *Distribution System* within pre-agreed settings.

2.7.1.6. Embedded generator will be to obtain the relevant licence from the ERB. It shall be the responsibility of an Embedded Generator to present a generating license to the DNSP.

2.7.1.7. *Embedded Generators* owning a *micro/mini-embedded generating installation* do not require a Generation Licence. However, these installations must be registered with the DNSP. This is both a safety issue and a network security issue; registration is not intended to restrict connection, but rather provide for safety and information for future planning requirements.

2.7.1.8. Where a licence (or exemption) is required, evidence of either shall be provided to the DNSP prior to connection to the network.

2.7.2. Responsibilities of DNSPs to the Embedded Generators

2.7.2.1. If requested by the *Embedded Generator,* the *DNSP* shall provide information relating to the *Distribution System* capacity and loading to enable the *Embedded Generator* to identify and evaluate opportunities for connecting to the *Distribution System*.

2.7.2.2. The *DNSP* shall treat all applications for connection to the *Distribution System* by potential *Embedded Generators* in an open and transparent manner that ensures equal treatment for all *applicants*.

2.7.2.3. The *DNSPs* shall be responsible for the installation of the bi-directional metering equipment between the *DNSP* and the *Embedded Generator*'s generation facility.

2.7.2.4. The *DNSP* shall develop the protection requirement guide for connecting *Embedded Generators* to the *Distribution System* to ensure safe and reliable operation of the *Distribution System*.

2.7.2.5. Embedded Generators shall apply for connection to the Distribution System to the DNSP. A sample application form can be found in Appendix A. Each DNSP shall develop and publish its own application form for connecting Embedded Generators.

2.7.3. Provision of Planning Information

2.7.3.1. Before entering into a *connection agreement*, the *Embedded Generator* shall provide to the *DNSP* information relating to the Generator plant data, location and time scale, capacity and standby requirements as detailed in Appendix A.

2.7.3.2. The *DNSP* shall provide the *Embedded Generator* any information necessary for the *Embedded Generator* to properly design the connection to the *Distribution System.*

2.7.3.3. Embedded Generators shall specify, with all relevant details, in their application for connection if the generator facility to be connected shall have black-start and / or self-start capabilities.

2.7.4. Point Of Connection Technical Requirements

2.7.4.1. The *Embedded Generator* shall be responsible for the design, construction, maintenance and operation of the equipment on the generation side of the *point of connection*.

2.7.4.2. The *Embedded Generator* shall be responsible for the provision of the site required for the installation of the *DNSP* equipment required for connecting the generating facility.

2.7.4.3. The technical specifications of the connection shall be agreed upon by the participants based on the *Distribution System* Impact Assessment Studies.

2.7.4.4. A circuit breaker and visible isolation shall be installed at the *point of connection* to provide the means of electrically isolating the *Distribution System* from the generating facility.

2.7.4.5. The *Embedded Generator* shall be responsible for the circuit breaker to connect and disconnect the generator.

2.7.4.6. The location of the circuit breaker and visible isolation shall be decided upon by the *participants*.

2.7.4.7. The Embedded Generator shall pay for any expenses incurred by the DNSP on behalf of the *Embedded Generator* in line with the Tariff Chapter

2.7.4.8. Connection between the *Micro/Mini-embedded generating unit* (e.g. PV Array) and the *distribution network* must be via an *approved inverter* and the connection must be undertaken in accordance with this Code. DNSPs will generally connect single phase *small-embedded generating units* via *approved inverters* up to 10 kVA and three phase up to 30kVA. Three phase *Inverters* must be configured to ensure reasonably balanced output to all phases at all times whilst connected to the distribution system. All three phases of the

Inverter must simultaneously disconnect from, or connect to, our distribution system in response to protection or automatic controls (e.g. anti islanding trip and subsequent reconnection).

2.7.4.9. Where multiple single phase *Inverters* are connected to more than one phase, the *Inverters* must be interlocked and configured to behave as an integrated multiphase *Inverter* providing a reasonably balanced output to all connected phases at all times whilst connected to the distribution system. Alternatively, where *Inverters* cannot be interlocked by internal controls, the installation must be protected by a phase balance relay which must immediately isolate the *Inverter* in the absence of reasonable balance. The *Inverters* must be physically prevented from operating independently and all installed *Inverters* must simultaneously disconnect from, or connect to, the distribution system in response to protection or automatic controls (e.g. anti islanding trip and subsequent reconnection)

2.7.5. Protection Requirement for Embedded Generators

2.7.5.1. General Protection Requirements

2.7.5.1.1. The *Embedded Generator's* protection shall comply with the requirements of this code. *Embedded Generators* of nominal capacity greater than 10 MVA shall in addition to the requirements of this code, comply with the Zambian Grid code (Generator connection conditions under the Network chapter)

2.7.5.1.2. Additional features including inter-tripping, anti-islanding and generator plant status to be agreed upon by the *participants*.

2.7.5.1.3. The protection schemes used by the *Embedded Generator* shall incorporate adequate facilities for testing, monitoring and maintenance.

2.7.5.1.4. The protection scheme shall be submitted by the *Embedded Generator* for approval by the *DNSP* and / or the Transmission System Operator

2.7.5.2. Specific Protection requirements

2.7.5.2.1. Phase and Earth Fault Protection

2.7.5.2.1.1. The protection system of the *Embedded Generator* shall fully coordinate with the protective relays of the *Distribution System*.

2.7.5.2.1.2. The *Embedded Generator* shall be responsible for the installation and maintenance of all protection relays at the point *of connection*.

2.7.5.2.2. Under/Over-frequency Protection

2.7.5.2.2.1 Under and over frequency protection must be installed to ensure the embedded generator is disconnected from the Distribution System when the system frequency varies outside the nominated range. The frequency protection settings must be based on the embedded generator's proposed distribution network connection arrangement and operating requirements.

2.7.5.2.2.2 The *Embedded Generator* shall install under/over-voltage protection to disconnect the generating facility under abnormal network conditions as agreed between the DNSP and the Embedded Generator. Under and over voltage protection must be installed to monitor all three phases at the point of connection. This protection is set to ensure the generating system is disconnected from the Distribution system when the voltage varies outside predetermined values. In the event that the generating system is located remote from the point of connection, the DNSP may accept use of a local voltage reference source for use with under and over voltage protection.

The under and over voltage protection will be a two staged protection scheme, incorporating short term (less than 1 second) and long term (10 minute) voltage measurements. The customer's protection relays must be capable of at least a two stage protection scheme.

2.7.5.2.3. Faults on the Distribution System

The Embedded Generator shall be responsible for protecting its generation facility in the event of faults and other disturbances arising on the Distribution System.

2.7.5.2.4. Islanding

2.7.5.2.4.1. The DNSP shall specify when the Embedded Generator may remain connected if the section of the Distribution System to which the Embedded Generator is connected is isolated from the rest of the network.

2.7.5.2.4.2. The Embedded Generation facility shall be equipped with dead-line detection protection system to prevent the generator from being connected to a de-energized distribution system. The DNSP shall take reasonable steps to prevent closing circuit breakers onto an islanded network.

2.7.5.2.4.3. For unintentional network islanding, the Embedded Generator and the DNSP shall agree on methodology for disconnecting and connecting the Embedded Generator.

2.7.6. Quality of Supply requirements

2.7.6.1. Frequency Variations

The *Embedded Generation facility* shall remain synchronized to the *Distribution System* while the network frequency remains within the agreed frequency limitations subject to guidelines set by the System Operator

2.7.6.2. Power Factor

The power factor at the point of connection shall be maintained within the limits agreed upon by the Participants.

2.7.6.3. Fault Levels

2.7.6.3.1. The Embedded Generator shall ensure that the contractually agreed fault level contribution from the generation facility shall not be exceeded.

2.7.6.3.2. The DNSP shall ensure that the contractually agreed fault level in the network at the point of connection shall not be exceeded.

2.7.7. Telemetry

The *Embedded Generator* shall have the means to remotely report any status change of any critical function that may negatively impact on the *quality of supply* on the *Distribution System*.

2.8 Distribution System Planning and Development

2.8.1. Framework for Distribution System Planning and Development

2.8.1.1. The *DNSP* shall source relevant data from various sources including the following but not limited to:

a). Power Systems Development Master Plan (PSDMP);
b). Rural Electrification Master Plan (REMP);
c). *Customer* information, system performance statistics;
d). *Distribution* network load forecast, and government (Planning Authority); and
e). *Customer* development plans to establish the need for network strengthening.

2.8.1.2. The DNSP shall annually compile a 5-year load forecast at the DNSP's incoming points of supply including DNSP's cross-boundary connections.

2.8.1.3. The DNSP shall be responsible for compiling network development plans with a minimum window period of five years. These network development plans shall be reviewed at the least every 5 years.

The aim of network development plans is to ensure a capable network and should therefore include all relevant activities such as electrification and refurbishment. Such plans should be drawn up taking into account only available information. Unexpected loads or customer requests can be retrospectively added to the plan.

2.8.1.4. The network development plans and post release changes shall be submitted to the ERB upon request.

2.8.1.5. The network development plans shall be made available to customers on request and the Network development plan shall include;

a). Energy and Demand forecasts;
b). Distribution substation siting and sizing;
c). Distribution feeder routing and sizing;
d). Distribution Reactive Power compensation plan;
e). Other Distribution reinforcement plans; and of the technical and economic analysis performed to justify the Distribution Development Plans.

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

2.8.2. Network Investment Criteria

2.8.2.1. Introduction

2.8.2.1.1. Distribution *tariffs* should be sufficient to allow the necessary investments in the networks to be carried out in a manner allowing these investments to ensure the viability of the networks.

2.8.2.1.2. The DNSP shall invest in the Distribution System when the required development meets the technical and investment criteria specified by the ERB.

2.8.2.1.3. The need to invest must first be decided on technical grounds. All investments must be the least life-cycle cost technically acceptable solution, that is, shall provide for standard supply:

a). Minimum quality requirements in terms of ZS 387.
b). Minimum reliability and operational requirements as determined by this code and by the ERB.

2.8.2.1.4. The investment choice must be justified by considering technical alternatives on a least- life cycle cost approach. Least life cycle cost is the discounted least cost option over the lifetime of the equipment, taking into account the technical alternatives for investment, operating expenses and maintenance.

2.8.2.1.5. Calculations to justify investment shall assume a typical project life expectancy of 25 years, except where otherwise dictated by plant life or project life expectancy.

2.8.2.1.6. The following key economic and financial parameters shall be determined by the ERB approved process:

a). Discount rate
b). Customer interruption cost (cost of unserved energy)
c). Other parameters, such as tariffs and additional economic parameters.

2.8.2.2. General Investment Criteria

2.8.2.2.1. Investments should be prudent (that is justified) as a *least life-cycle cost* solution after taking into account, where applicable, alternatives that consider the following:

a). The investment that will minimize the cost of the energy supplied and the *customer* interruption cost (cost of unserved energy).
b). Current and projected demand on the network.
c). Reduction of *life-cycle costs* e.g. reduction of technical losses, operating and maintenance costs and telecommunication projects
d). Current condition of assets and refurbishment and maintenance requirements.
e). Demand and supply options.
f). Any associated risks.

2.8.2.2.2. General (shared) network investments shall be evaluated on the least-life-cycle economic cost. Economic cost will consider the least life cycle total cost of the electricity related investment to both the DNSP and the customer.

2.8.2.2.3. Investments made by the DNSP dedicated to a particular customer shall be evaluated on a least life-cycle DNSP cost. DNSP cost will consider only the least-life cycle investment cost to the DNSP.

2.8.2.2.4. The DNSP shall evaluate investments in terms of the following categories:

a). *Shared network investments*
b). Dedicated customer connections.
c). *Statutory investments*.
d). International connections (cross-border connections)

2.8.2.3. Least economic cost criteria for shared network investments

2.8.2.3.1. Shared network investments are:

a). Investments on shared infrastructure (not-dedicated) assets;
b). Investments required to provide adequate upstream network capacity;
c). Investments required to maintain or enhance supply reliability and/or quality to attain the limits or targets, determined in section 2.6.3 of this code, on existing network assets;
d). Refurbishment of existing standard dedicated connection assets.

2.8.2.3.2. All shared network investments are to be justified on least economic cost. In determining the least economic cost for shared network investments the investment must be justified to minimise the cost to the electricity industry and not just to the DNSP.

2.8.2.4. Least life cycle cost criteria for standard dedicated customer connections

2.8.2.4.1. A standard connection is defined as the lowest *life-cycle costs* for a technically acceptable solution and will be charged for as described in section 6.10.2 in the Tariff Chapter.

2.8.2.4.2. Dedicated customer connections are:

a). New connection assets created for the sole use of a *customer* to meet the *customer's* technical specifications.
b). Dedicated assets are assets that are unlikely to be shared in the DNSP's planning horizon by any other end-use *customer*.

2.8.2.4.3. All dedicated connection investments are to be justified on the technically acceptable least life-cycle costs.

2.8.2.4.4. Where the investment meets the least life-cycle cost, the customer shall be required to pay a standard connection charge as described in the Tariff Code.

2.8.2.4.5. For certain customer groupings, as approved by the ERB, the investments shall be justified collectively as per customer grouping and not per customer.

2.8.2.4.6. The DNSP will refurbish / replace / reconfigure all equipment to meet standard supply criteria at no cost to the customer and this will be allowed to be recovered in the use of system (network) charges. This will be a non-discriminatory approach where no consideration will be given to the special or unique requirements of the customer.

2.8.2.5. Investment criteria for premium customer connections

2.8.2.5.1. A *premium connection* is where a customer contracts with the *DNSP* for additional specific requirements not justified in the investment criteria for standard dedicated customer connections.

2.8.2.5.2. The DNSP shall investigate these additional requirements and will provide a least life-cycle cost solution.

2.8.2.5.3. If the customer agrees to the solution, all costs to meet the customer requirement in excess of what is considered the least life-cycle cost investment is payable as a premium connection charge by the customer as described in section 6.10.3 of the Tariff Code. Such costs shall be appropriately pro-rated, if a portion of the investment can be justified based on improved reliability or reduction of costs.

2.8.2.5.4. The refurbishment of identified premium connection assets will occur when the equipment is no longer reliable or safe for operation. The DNSP must justify the need for refurbishment of the premium assets to the customer, and the customer must agree to the continuance of the premium supply.

2.8.2.5.5. At the time of refurbishment, should the customer have any requirements that cannot be met in terms of the standard connection, any additional investment will be seen as a premium connection.

2.8.2.5.6. Where the refurbishment of a supply in accordance with current technical standards will result in additional cost to the customer, an engineering solution that minimises the sum of the DNSP's and the customer's costs will be found. This least economic cost option will be implemented but any expenditure in excess of the DNSP least life-cycle cost solution under General Investment Criteria and standard customer connection criteria (as per 2.8.2.2 and 2.8.2.4 above) will be borne by the customer through a new premium connection charge and shall not be recovered through use-of-system (network) charges.

2.8.2.6. Statutory or strategic investments

2.8.2.6.1. *DNSPs* will be obligated to make *statutory investments* in terms of clause 2.8.2.6.3 below.

2.8.2.6.2. Statutory and strategic investments will be motivated on a least economic cost basis, as defined in 2.8.2.3.

2.8.2.6.3. Strategic and statutory projects include the following:

a). Investments formally requested in terms of published government policy but not considered dedicated *customer* as under (section 2.8.2.4) standard connection;
b). Projects necessary to meet environmental legislation, e.g. the construction of oil containment dams;
c). Expenditure to satisfy the requirements on the *DNSP* to comply with the *Factories Act*; this classification is intended to ensure the safety of operating and maintenance personnel who are exposed to possible danger when busy with activities related to electricity distribution;
d). Possible compulsory contractual commitments;
e). Servitude acquisition;
f). *Generators*;

2.8.2.7. Investment criteria for international connections

The investment for international *customers* shall be in terms of the criteria set out for a dedicated connection, but the *DNSP* shall charge a *connection* *charge* that ensures that there is no cross border subsidies, as set out in the Tariff Chapter.

2.8.2.8. Excluded services

2.8.2.8.1. Excluded services may be competitive or provided by the *DNSP* as a monopoly service.

2.8.2.8.2. Monopoly services are those mandatory services to ensure a standard of work that meets quality of supply, reliability and safety standards.

2.8.2.8.3. Excluded services include the following:

a). Design and construction of the customers own local system outside the boundary point of connection from the DNSP.

b). Recoverable works such as inspection and maintenance of non-*DNSP* owned installations, line relocation and other requested recoverable works.

c). The construction and maintenance of public lighting assets.

2.8.2.8.4. For excluded services, customers will be allowed to choose a contractor other than the DNSP, provided that an agreement is reached between the DNSP and the customer prior to the project being undertaken detailing the conditions. These conditions will set out the following:

a). The assets the customer is allowed to work on or not.

b). The terms and conditions for the approval of the network design.

c). The terms and condition for the inspection and the work done prior to any agreement to take over and/or commission the supply.

d). The charges to be raised by the *DNSP* for monopoly related services.

2.8.2.8.5. The fees charged by the DNSP for excluded services may be regulated.

3. SYSTEM OPERATING CHAPTER

3.1. Objective

To set out the responsibilities and roles of the participants as far as the operation of the Distribution System is concerned and more specifically issues related to:

a). economic operation, reliability and security of the Distribution System
b). operational authority, communication and contingency planning of the Distribution System
c). management of power quality
d). operation of the Distribution System under normal and abnormal conditions
e). field operation, maintenance and maintenance coordination/ outage planning
f). safety of personnel and public

3.2. Scope of Application

The *Distribution System Operating Code* shall apply to all *Participants* of the Distribution System including:

a). DNSPs
b). Embedded Generators
c). Generators
d). End-use customers
e). Traders / Retailers
f). Resellers
g). Any other entities with equipment connected to the Distribution System (for example transmission network service providers (TNSPs))
h). System Operator (SO)
i). Regional Operator
j). Any other entities with equipment connected to the Distribution System

3.3. Operational Responsibilities of DNSPs

3.3.1. The *DNSP* shall operate the *Distribution System* to achieve the highest degree of reliability and shall promptly take appropriate remedial action to relieve any condition that may jeopardise reliability.

3.3.2. The DNSP shall co-ordinate voltage control, demand control, operating on the Distribution System and security monitoring in order to ensure safe, reliable, and economic operation of the Distribution System.

3.3.3. In the event of an embedded generator having to shut down or island plant because of a disturbance on the Distribution network, the DNSP shall carry out network restoration to minimize the time required to resynchronize the shed embedded generating units.

3.3.4. Ensuring that the availability and reliability of every power station supply is maximised at all times under normal and abnormal conditions

3.3.5. The DNSP may shed customer load to maintain system integrity. Following such action, customer load shall be restored as soon as possible after restoring and maintaining system integrity.

3.3.6. The DNSP shall operate the Distribution System as far as practical so that instability, uncontrolled separation or cascading outages do not occur.

3.3.7. The DNSP is responsible for efficient restoration of the Distribution System after supply interruptions. The restoration plans shall be prioritised in accordance with customer requirements and as described in ZS 397.

3.3.8. The DNSP shall ensure it has sufficient resources to continuously monitor and operate the Distribution System.

3.3.9. The DNSP shall establish and implement operating instructions, procedures, standards and guidelines to cover the operation of the Distribution System under normal and abnormal system conditions.

3.3.10. The DNSP shall operate the Distribution System within defined technical standards and equipment operational ratings.

3.3.11. The DNSP shall ensure adequate and reliable communications to all major users of the Distribution System. Communication with all customers shall be provided in terms of the ERB license requirement.

3.4. Operational Responsibilities of Embedded Generators and Other Customers

3.4.1. When conditions on the *Distribution System,* under normal or abnormal conditions, become such that it may jeopardise customers' plant or personnel*, customers* shall immediately disconnect from the *Distribution Syste*m.

3.4.2. The Embedded Generator shall ensure that its generating units are operated within the capabilities defined in the Connection Agreement entered into with the DNSP.

3.4.3. The Embedded Generator shall reasonably cooperate with the DNSP in executing all the operational activities during an emergency generation condition.

3.4.4. Customers shall assist the DNSPs in correcting quality of supply problems caused by the Customer's equipment connected to the Distribution System.

3.4.5. Customers shall at all times operate their equipment in such a manner to ensure that they comply with the conditions specified in their supply agreement.

3.4.6. All customers must declare any co-generating plant (whether licensed or not) and specify the interlocking mechanism to prevent inadvertent parallel operation with the DNSP network.

3.4.7. Embedded generators shall have the required protection to trip in the event of a momentary supply loss causing an island condition to prevent paralleling out of synchronism due to auto-reclose functionality on the DNSP's network.

3.5. Operational Authority

3.5.1. The *DNSP* shall have the authority to instruct operations on the *Distribution System*. Operational authority for other networks shall lie with the respective asset owners.

3.5.2. Network control, as it affects the interface between the DNSP and a customer, shall be in accordance with the operating agreements between the participants.

3.5.3. Except where otherwise stated in this code, no participant shall be permitted to operate the equipment of another without the permission of such other participant. In such an event the asset owner shall have the right to test and authorise the relevant operating staff in accordance with its own standards before such permission is granted.

3.5.4. Notwithstanding the provisions of section 3.3 (Operational Responsibilities of DNSPs) of this code, participants shall retain the right to safeguard their own equipment.

3.6. Operating Procedures

3.6.1. The *DNSP* shall develop and maintain operating procedures for the safe operating of the *Distribution System*, and for assets connected to the *Distribution System*. These operating procedures shall be adhered to by *participants* when operating equipment on the *Distribution System* or connected to the *Distribution System*.

3.6.2. Each customer shall be responsible for his own safety rules and procedures at least in compliance with the relevant safety legislation. Customers shall ensure that these rules and procedures are compatible with the DNSP developed procedures defined in 3.6.1 above.

3.6.3. Customers and service providers shall enter into operating agreements, where not included in the supply agreement, as defined in the service provider licenses.

3.7. Operational Liaison

3.7.1. The *DNSP* shall be responsible for ensuring adequate operational liaison with connected *participants*.

3.7.2. The participants shall appoint competent personnel to operate their network and where needed shall establish direct communication channels amongst themselves to ensure the flow of operational information between the participants.

3.7.3. If any participant experiences an emergency, the DNSP may call upon other participants to assist to an extent as may be necessary to ensure that such emergency does not jeopardise the integrity of the Distribution System.

3.7.4. Pursuant to 3.7.3 above, the relevant participant shall ensure that the emergency notification contain sufficient details in describing the event including the cause, timing and recording of the event to assist the DNSP in assessing the risk and implications to the Distribution System and all the affected Customers' equipment.

3.7.5. For planned events, which have an identified operational effect on the Distribution System, or on Customers' equipment connected to the Distribution System, the relevant participant shall notify the DNSP.

3.7.6. Where it is possible for a customer to parallel supply points or transfer load or embedded generation from one point of supply to another by performing switching operations on the customer's network, the operating agreement shall cover at least the operational communication, notice period requirements and switching procedures for such operations.

3.7.7. The DNSP and customers shall agree on the busbar configuration(s) at each point of supply during normal and emergency conditions. The DNSP shall keep updated records of such agreements.

3.8. Emergency and Contingency Planning

3.8.1. The *DNSP* shall develop and maintain emergency and contingency plans to manage the system contingencies and emergencies that affect the service delivery of the *Distribution System* and the Interconnected Power System.

Such plans shall be developed in consultation with all affected *participants*, and shall be consistent with internationally acceptable practices, and shall include but not be limited to:

a). under-frequency load shedding

b). Prevention of voltage slide and collapse meeting any national disaster management requirements including the necessary minimum load requirements
c). forced outages at any point of connection
d). ensuring continuation of supply to every power station during normal and abnormal conditions
e). Supply restoration.

3.8.2. Emergency plans shall enable the safe and orderly recovery from a partial or complete system collapse, with minimum impact on customers.

3.8.3. All contingency and emergency plans shall be reviewed every two years or in accordance with changes in network conditions.

3.8.4. All contingency and emergency plans shall be verified by audits, if possible by using onsite inspections actual tests and simulations. In the event of such tests causing undue risk or undue cost to a participant, the DNSP shall take such risks or costs into consideration when deciding whether to conduct the tests.

Any tests shall be carried out at a time that is least disruptive to the participants. The costs of these tests shall be borne by the respective asset owners. The DNSP shall ensure the co-ordination of the tests in consultation with all affected participants.

3.8.5. The DNSP shall, in consultation with the TNSP and SO, set the requirements and implement:

a). Automatic and manual under frequency load shedding in accordance with the *System Operator's* requirements.
b). Automatic and manual under voltage load shedding to prevent voltage collapse.
c). Manual load shedding to maintain network integrity.

3.8.6. Participants shall make available loads and schemes with appropriate signals including under frequency, under voltage breaker status etc to comply with clause 3.8.5.

3.8.7. The DNSP shall be responsible for determining emergency operational limits on the Distribution System, updating these periodically and making these available to the participants.

3.8.8. The DNSP shall conduct network studies which may include but not be limited to load flow, fault level, stability and resonance studies to determine the effect that various component failures would have on the reliability of the Distribution System.

3.9. Operation during Abnormal Conditions

3.9.1. During *abnormal operating conditions* the *DNSP* shall be obliged to take necessary precautionary measures to prevent network disturbances from spreading and to restore supply to *consumers*.

3.9.2. The *DNSP* shall cooperate with the *SO, TNSP* and *RO* in taking corrective measures in the event of abnormal conditions on the *Distribution System*. The corrective measures shall include both supply-side and demand-side options. Where possible, warnings shall be issued by the *DNSP* to affected *participants* on expected utilisation of any contingency resources.

3.9.3. The *DNSP* shall be entitled to disrupt some sections of the network in the event of a prolonged disturbance resulting from unsuccessful corrective measures undertaken.

3.9.4. Termination of the use of emergency resources shall occur as the order of return being determined by the most critical loads, first in terms of safety and then plant.

3.9.5. During emergencies that require load shedding, the request to shed load shall be initiated in accordance with procedures prepared by the *DNSP*.

3.10. Independent Actions by Participants

3.10.1. Each *participant* shall have the right to reduce supply or demand, or disconnect a *point of connection* under emergency conditions, if such action is necessary for the protection of life or equipment and shall give advance notice of such action where possible. Where a point of connection has been disconnected under emergency conditions without giving advance notice, the participant who has carried out such action shall notify the other participants immediately after carrying out such action.

3.11. Demand and Voltage Control

3.11.1. The *DNSP* shall implement demand control measures when:

a). Instructed to by the SO or RO;
b). Abnormal conditions exist on the *Distribution System*,
c). Multiple outage contingency exists resulting in *island* grid operation
d). Any other operational event the *DNSP* deems to warrant the implementation of demand control measures for the safe operation of the *Distribution System*.

3.11.2. Demand control shall include but not limited to:

a). *Customer* demand management

b). Automatic under-frequency load shedding
c). Automatic under-voltage load shedding
d). Emergency manual load shedding
e). Voluntary load curtailment

3.11.3. The DNSP shall develop load reduction procedures, which shall be regularly updated, to reduce load in a controlled manner taking cognisance of the type of load.

3.11.4. The DNSP shall endeavour to maintain system voltage to be within statutory limits at the points of supply or otherwise as agreed in the operating/supply agreement.

3.12. Fault Reporting and Analysis/Incident Investigation

3.12.1. The *end-use customers* and *Embedded Generators* shall report the loss of major loads or *generation* (as agreed by the *participants*) to the *DNSP* within 15 minutes of the event occurring. Notice of the intention to reconnect such shall be given with at least 15 minutes advance notice to enable the *DNSP* to take any necessary action required.

3.12.2. The DNSP shall investigate all incidents that materially affected the quality of supply to another participant. The DNSP shall initiate and co-ordinate such an investigation and make available the findings of such investigation to affected participants on request.

3.12.3. The findings of such an investigation shall include where relevant:

a). Date and time of the incident
b). Location of the incident
c). Duration of the incident
d). Equipment involved
e). Cause of the incident in compliance with ZS 397
f). Demand control measures undertaken specifically recording the customer MWs shed and energy lost as a result of the measures taken.
g). Supply restoration details.
h). *Embedded Generation* interrupted
i). Under-frequency Load shedding response
j). Estimated date and time of return to normal service
k). *Customer* load tripped MW and energy lost when incident occurred or as a direct result of incident not including any Demand Control Measures taken
l). Estimate number of *customers* having lost supply.
m). Recommendations

3.12.4. Any participant shall have a right to request an independent audit of the findings, at its own cost. If these audit findings disagree with the original findings, the participant may follow the dispute resolution mechanism as specified in the Governance Chapter.

3.13. DNSP Maintenance Program

3.13.1. Each *DNSP* shall have a maintenance philosophy against which their maintenance practices and programs are compiled and documented in accordance with utility best practice. These documented maintenance programs must be auditable.

3.13.2. The DNSP shall compile at least an annual maintenance plan in line with the budget period.

3.13.3. Accurate records of maintenance done shall be kept for a period of at least 5 years.

3.13.4. The DNSP shall schedule planned outages in coordination with the maintenance requirements of other participants connected to the affected network.

3.13.5. All participants that may be affected by the planned outages will be informed at least five days in advance.

3.14. Testing and Monitoring

3.14.1. A *participant* has the right to request to test and / or monitor any equipment at the p*oint of connection* to the *Distribution System* to ensure that the *participants* are not operating outside the technical parameters specified in any part of the *Distribution Grid Code* and other applicable standards which the *participants* are required to comply with. Such testing and / or monitoring shall be carried out as mutually agreed by the *parties*.

3.14.2. A participant found to be operating outside the technical parameters shall, within such time agreed upon by the parties involved, remedy the situation or disconnect from its network the equipment causing problems.

3.14.3. Any dispute arising out of the test and monitoring process shall be resolved through the dispute resolution mechanism in the *Governance Chapter*

3.15. Safety Co-ordination

3.15.1. The *DNSP* shall comply with relevant legislation and develop Operating Regulations to ensure safety of personnel whilst operating on the *Distribution System* or any equipment connected to the *Distribution System*.

3.15.2. Where operational boundaries exist, there shall be a joint agreement on operating procedures to be complied with by all affected participants.

3.15.3. There shall be written authorization of personnel who operate on or work on live equipment forming part of or connected to the Distribution System.

3.15.4. The "Operating Regulations" referred to in section 3.15.1 of this code shall include rules and regulations for the safe operating of plant, continuity of supply and authorization of personnel related to the operating of HV/EHV, MV and LV equipment.

3.16. Disconnection and Reconnection

3.16.1. The *DNSP* may disconnect supply to the *customer's* supply address if the *customer* fails to comply with the written notice of non-compliance issued by the *DNSP* or any arrangement entered into by the *DNSP* and the *customer* which the *customer* has failed to comply with including non-compliance with the *DNSP* applicable standards.

3.16.2. The DNSP shall have the right to interrupt or disconnect supply if a threat of injury or material damage is anticipated as a result of the malfunctioning of the electrical installation equipment on the Customer's premises or on the Distribution System.

3.16.3. The DNSP may disconnect immediately without notice the supply to the customer's supply address if:

a). The supply of electricity to a *customer* is used anywhere else other than at the *customer's* premises as specified in the *connection agreement*.
b). A *customer* takes at the *customer's* supply address electricity supplied to another *customer*.
c). A *customer* is tampering with or permits tampering with the meter and associated components.
d). A *customer* allows electricity supply to bypass the meter without the *DNSP's* consent.

3.16.4. Customer (connected at MV and HV/EHV levels) shall give at least five days written notice to the DNSPs of any intended voluntary disconnection.

3.16.5. The DNSP shall reconnect supply to the customer on request by the customer or retailer on behalf of the customer subject to compliance with the relevant provisions of the Distribution Grid Code and other DNSP applicable standards including the timing of reconnection and any reconnection charge imposed by the DNSP.

3.17. Commissioning and Connection

3.17.1. MV and HV/EHV *customers* shall supply commissioning programmes to the *DNSP* control and operating facility at least 1 month in advance. Subsequently, a notice of first connection shall be given to the *DNSP* control and operating facility at least 2 weeks before actual connection. Details of the information required shall include but not limited to the following:

a). Commissioning procedures and programmes
b). Documents and drawings required
c). Proof of compliance with standards
d). Documentary proof of the completion of all required tests
e). SCADA information, to be available and tested before commissioning
f). Site responsibilities and authorities.

3.17.2. When commissioning equipment at the point of connection, the DNSP shall liaise with the affected participants on all aspects that could potentially affect their operation.

3.17.3. The DNSP and customers shall perform all commissioning tests required in order to confirm that the DNSP's and the customers' plant and equipment meet all the requirements of the Distribution Grid Code before being connected to and energized from the Distribution system.

3.18. Outage scheduling and co-ordination

3.18.1. Responsibilities of the *DNSP*

3.18.1.1. *DNSPs* shall, with reference to the relevant network *Service Providers* outage plans and relevant *Generators* outage programs, compile the daily outage schedule which shall:

a). endeavour to cater for the planned maintenance and commissioning of new equipment
b). describe the planned outage
c). identifies the risks and impact on network performance describe the practical contingency plans devised to counter risks, and
d). define the roles and responsibilities of the personnel designated to manage and minimize the impact of these outages on the *Distribution System* and its users.

3.18.1.2. Notwithstanding clause 3.18.1.1 above, the DNSP shall co-ordinate relevant outages with the SO.

3.18.1.3. In addition to paragraph 3.18.1.1 above, the DNSP may require information from the Customers regarding major plant and associated equipment which may affect the performance of the Distribution System and may require additional resources to be committed during the outage planning process.

3.18.1.4. Customers with co-generation and Embedded Generators with the maximum capacity greater than 1MW shall furnish to the DNSP information on planned outages in order for the DNSP to properly plan, and coordinate its control, maintenance and operation activities.

3.18.1.5. The Distribution outage schedule shall be submitted to the ERB upon request.

3.18.2. Risk-related Outages

3.18.2.1. All risk-related outages shall be scheduled with an executable contingency plan in place. The compilation of the contingency plan is the responsibility of the relevant *DNSP*.

3.18.2.2. Contingency plans shall address:

a). Safety of personnel
b). Security and rating of equipment
c). Continuity of supply

3.18.2.3. The relevant control centres shall confirm that it is possible to execute the contingency plan successfully.

3.18.3. Communication of System Conditions, Operational Information and Distribution System Performance

3.18.3.1. The *DNSP* shall be responsible for providing *participants* with operational information as may be agreed from time to time. This shall include information regarding *planned* and *forced outages* on the *DNSP*.

3.18.3.2. The DNSP shall inform participants of any network condition that is likely to impact the short and long-term operation of that participant.

3.18.3.3. The DNSP shall record operational information as specified in the Information Exchange Code. This information shall be made available to all participants on request.

3.18.4. Unplanned Interruptions or Outages

3.18.4.1. In case of unplanned interruptions or *outages* the *DNSP* may require a *customer* to comply with reasonable and appropriate instructions from the *DNSPs* and may further:

a). Require the *customer* to provide the *DNSP* emergency access to *customer* owned distribution equipment normally operated by the *DNSP* or *DNSP* owned equipment on *customer's* property.

b). Interrupt supply to the *customer* to effect repairs to the *Distribution System*.

3.18.4.2. Subsequent to clause 3.18.4.1, the DNSP shall make arrangements to keep customers informed about the expected duration and other details following unplanned interruptions.

3.18.5. Refusal/Cancellation of Outages

3.18.5.1. No participant may unreasonably refuse an outage request, postpone or cancel a previously accepted outage.

3.18.5.2. In the event of cancellation/postponement of an outage each participant shall bear its own cost. Where the cancellation/ postponement is unreasonable, the cost shall be borne by the participant who caused the cancellation/ postponement.

3.18.6. Planned Interruptions or Outages

For planned interruptions or outages the *DNSP* shall act in accordance with the ZS 397 and provide the affected *Customers* with information relating to the expected date of the outage, time and duration of the outage and shall establish reasonable means of communication to the *Customers* for outage related enquiries.

3.19. Tele-control

Where Tele-control facilities are shared between the *DNSP* and other *participants*, the *DNSP* shall ensure that operating procedures are established in consultation with the *participants*.

4. METERING CHAPTER

4.1. Objectives

4.1.1. To ensure compliance with minimum requirements for tariff metering and energy trading metering installations;

4.1.2. To define responsibilities for metering installations.

4.1.3. To ensure that appropriate procedures are followed by the DNSP of electricity (referred to as 'licensee' in ZS 397 and in this code) and its metering service provider regarding the maintenance, validation, collection, processing and verification of metering data.

4.2. Scope of Application

4.2.1. The Metering Chapter shall apply to:

a). *Transmission Network Service Providers (TNSPs)*
b). *DNSPs*
c). Embedded Generators/Net metering
d). *Traders / Retailers*
e). *Resellers*
f). Metering *service providers* contracted by *participants*
g). Other entities with equipment connected to the *TNSPs* or *Distribution System*

4.2.2. The provisions for customers' rights and obligations in this code shall be referenced in the connection agreements with the licensee.

4.3. Application of the Metering Chapter

This chapter is applicable to:

a). metering installations used for the measurement of active and (where relevant) reactive energy and demand (where relevant)
b). the design of the metering installation
c). the provision, installation, commissioning and maintenance of metering equipment
d). the minimum requirements of equipment used in the process of electricity metering
e). testing procedures for metering installations
f). the collection and verification of metering data
g). storage requirements for metering data,
h). standards for the competencies of *participants*.
i). net metering for participants connecting to distribution system

4.4. General Provisions

4.4.1. ZS 647: *Code of practice for* electricity metering specifies the minimum requirements that *metering installations* and *metering service providers* shall comply with. This code regulates conformance to these requirements.

4.4.2. The *licensee* shall only make use of metering equipment that has been certified by an accredited laboratory in terms of ZS 647.

4.4.3. Should there be a conflict in the interpretation between these provisions and any other national rationalized specification; the metering code shall take precedence.

4.5. Metering requirements

4.5.1. Installation design requirements

4.5.1.1. The licensee shall ensure that the design of a metering installation complies with all requirements as specified in *ZS 647* including the following:

a). The requirements for main and check or backup metering equipment;
b). The requirement for full four quadrant metering to be installed where active and reactive energy flow is in both directions.
c). The requirements for primary plant (Current and Voltage instruments transformers) where relevant.
d). The requirements for the meters specified to cater for the requirements of the applied tariff to the *customer*;
e). The requirements for metering data retrieval equipment to be catered for in the design based on the requirements of the licensee. For all *TNSPs* metering installations equipment shall be installed to allow for remote interrogation of metering data.
f). Where *AMR (automated meter reading*) is utilized for large customers then the appropriate standard shall be complied with.

4.5.1.2. Metering equipment shall preferably be installed at the point of supply which defines the commercial boundary between the licensee and the customer. Where this is not possible, the metering point shall be located at the point agreed between the licensee and the customer.

4.5.2. Metering equipment installation

4.5.2.1. Where own metering staff or metering *service providers* are contracted for any work related to metering, the *licensee* remains accountable to ensure compliance with the requirements of the metering code and the technical requirements referenced therein. The *DNSP (or licensee*) shall thus only appoint own metering staff or metering service providers that have the necessary skills and authorization to install metering equipment.

4.5.2.2. All primary and secondary metering equipment shall be calibrated before installation

4.5.2.3. Commissioning of equipment shall be done following procedures that cater for the minimum testing requirements

4.5.3. Metering equipment maintenance

4.5.3.1. The electricity *DNSP (or licensee*) shall appoint own metering staff or metering *service providers* that have the necessary skills and authorization to maintain metering equipment.

4.5.3.2. Metering installations shall be maintained according to the requirements and frequency specified in *ZS 647*

4.5.3.3. For prepayment meters the inspection procedure shall be followed as stated in ZS IEC 62055-31.

4.5.4. Metering equipment access

4.5.4.1. Metering equipment owned by the *licensee*, *retailer* or *metering service provider* but installed on the *customer's* premises shall remain the property of the *service provider*.

4.5.4.2. *Customers* shall not tamper or permit tampering with metering equipment owned by the licensee or any other *service provider*.

4.5.4.3. Except with written consent by the owner, access by *customers* or *customer* representatives to meters, metering circuits and metering data shall be restricted to ensure that the integrity of the metering device, metering installation and meter data are not at risk.

4.5.4.4. *Customers or custome*r representatives shall not have direct access to meters to obtain any metering information. Direct access includes access gained by downloading the metering information from the meter directly through the digital communication interface, or remotely through any communication media such as a PSTN or GSM modem, or any other means other than visual access. Requests from *customers* to read their own meters shall not be unreasonably refused.

4.5.4.5. Except with written consent by the owner, *customers* or *customer* representatives shall not install any metering or other equipment integrated into the licensees *CT* and *VT* metering circuits, test blocks, terminals, or any portion forming part of the electrical metering installation.

4.5.4.6. *Customers* shall provide reasonable access to the metering equipment owned and operated by the *licensee*, *metering service provider* or *retailer* but installed on the *Customer's* premises provided an official identification is produced on request.

4.5.4.7. Where metering installation is situated in a restricted area, then a procedure (s) applicable legislation and/ or as agreed between the parties shall be followed to gain access to the equipment.

4.5.4.8. If a *customer* or his representative requires real time energy pulses (kWh & kVArh) at a metering installation, the licensee shall provide the real-time energy pulses through mutual agreement. The *customer* shall bear the costs of installation in such an event.

4.5.4.9. Any changes that may affect the parties' authorised and safe access to the metering equipment shall be reported as soon as it is brought to either party's attention.

4.5.5. Metering data access

4.5.5.1. Official metering data shall be made available by the *licensee* on request by the *customer* in a format agreed upon between the parties.

4.5.5.2. The *licensee* shall make available all formats at which it can provide data to the *participant*.

All new formats shall be negotiated between the *licensee* and the affected *participant*.

4.5.5.3. The *licensee* shall store all metering data information in a central database for at least 5 years. The *licensee* shall ensure that the database is maintained and continuously updated. The data shall be made available upon request by the regulator.

4.5.5.4. Non-standard data provision format shall be provided by the *licensee*, where possible, at the expense of the requesting party.

4.5.6. Metering data retrieval

4.5.6.1. The frequency of meter reading shall comply with the requirements of *ZS 647*.

4.5.6.2. *Licensees* shall ensure that the necessary data retrieval equipment and process are in place to achieve the meter read frequency as specified.

4.5.6.3. The metering data retrieval process for automated meter reading *(*AMR) on large power user installations shall be a secure process whereby meters or recorders are directly interrogated to retrieve billing information from their memories.

4.5.6.4. Pre-payment metering installations are excluded from the requirements of this section (section 4.5.6.).

4.5.7. Data Validation and Verification

4.5.7.1. The *licensee* shall carry out data validation and verification in accordance with *ZS 647*.

4.5.7.2. In the event of a substitution being made to metering data, the licensee or any other authorised person responsible for metering data validation or verification shall consult with the *customer* about the substitution and the basis upon which the substitution was made. No consultation is required for, where practised, the domestic account 3 monthly reconciliation processes.

4.5.7.3. The licensee shall maintain a journal according to ZS 647 of the substitution made and provide access to the record when requested by the customer.

4.5.8. Metering Database

The *licensee* shall create, maintain and administer a metering database containing in addition to meter measurement data the following *information*:

a). Name and unique identifier of the metering installation;
b). The date on which the metering installation was commissioned;
c). The connecting parties at the metering installation;
d). Maintenance history schedules for each metering installation;
e). Telephone numbers used to retrieve information from the metering installation;
f). Type and form of the meter at the *metering installation*;
g). Fault history of a metering installation; and
h). Commissioning documents for all metering installations.

The *service provider* shall retain *metering information* for at least five years for audit trail purposes.

In the event of testing revealing that data in the metering database is inaccurate, the *licensee* shall inform all affected participants and corrections shall be made to the official metering data and the associated billing by mutual agreement.

4.6. Confidentiality of Metering Data

Metering data for use in energy trading and billing is confidential information and shall be treated in accordance with the Information Exchange Chapter.

4.7. Customer queries on Metering integrity and Metering Data

4.7.1. Where *customers* indicate they have a query or complaint related to metering, the *licensee* shall comply with the applicable requirements of *ZS 647*.

4.7.2. Any *participant* may request the *licensee* or *metering service provider*, to test a metering installation. Such a request shall not be unreasonably refused. The costs of such test shall be for the account of the *licensee* unless the metering equipment is found to be within specification, in which event the cost shall be borne by the requesting *participant*.

4.7.3. Alternatively, a *customer* may request an independent audit of metering installations done by approved metering *service providers*. The selection of the approved metering *service provider* shall be mutually agreed upon between the two parties. The requesting *participant* shall be responsible for any costs unless the metering installations are proved to be outside the defined standards. The costs of such test shall be for the account of the licensee unless the metering equipment is found to be within specification, in which event the cost shall be borne by the requesting participant.

4.7.4. If errors are found with the metering after testing or auditing then the *customer's* account will be adjusted according to the rectified data.

4.7.5. The audit result shall be submitted to the licensee and the licensee shall respond to the customer within 30 calendar days on any account or metering adjustments proposed in the audit report.

4.7.6. Customers shall have the right to request an audit of the settlement process related to their account and the right to choose an independent third party qualified to perform the audit. The costs of such audit shall be for the account of the licensee unless the account is found to be within specification, in which event the cost shall be borne by the customer.

4.7.7. Should no agreement be reached on account or metering disputes between the customer and the licensee the dispute resolution procedure shall be followed as stipulated by in the Governance Code.

4.8 Net Metering

4.8.1 General

4.8.1.1 The objectives of net metering are:

a). the generation of additional power into the national grid, reducing the investment requirements of utilities and conventional independent power producers
b). to allow customers to reduce their imports from distribution networks through generating for own consumption;
c). to allow customers to export to distribution networks up to the net-metering-customers' imports from distribution networks;
d). the promotion of sustainable renewable energy sources, small scale investments, value addition and electricity market development;

4.8.1.2 All distribution utilities shall offer net metering to customers subject to these guidelines and other applicable Zambian laws, rules and regulations.

4.8.1.3 The ERB may amend and review these guidelines if and when it is deemed necessary.

4.8.2 Eligible Generation Technologies and Consumer Classes

4.8.2.1 All renewable energy technologies are eligible for net metering including, but not limited to facilities for the production of electrical energy that uses solar, wind, water, geothermal, biomass, biogas, biofuel, or fuel cell resources.

4.8.2.2 All distribution consumers are allowed to install net metered facilities subject to the Energy Regulation Act, Electricity Act and other applicable rules and regulations.

4.8.3 Generation Capacity Limits

4.8.3.1 The on-site generation capacity of each net metered facility shall not exceed the lower of the facility's main electricity supply circuit breaker current rating (60A and/ or 100 kVA); the level of penetration of net metering has to be coordinated with the amount of renewable energy generation that the DNSPs facilities can technically handle.

Studies need to be done to assess the actual quantum.

4.8.3.2 The aggregate generation capacity of net metered facilities in a particular distribution licensee's licensed area shall be determined by the distribution licensee in accordance with;

a). the distribution licensee's electrical infrastructure equipment ratings upstream of net metered facilities;
b). limits imposed by the distribution network's stability requirements as specified under the distribution network code and determined by technical studies performed by, and practical experiences of the distribution licensee.

4.8.3.3 Distribution licensees shall inform the Energy Regulation Board in detail of any aggregate generation capacity limits contemplated in 4.8.3.2, within a reasonable period of such limits becoming known to the distribution licensees. Such aggregate generation capacity limits are subject to the technical appraisal and approval of the ERB before implementation.

4.8.3.4 Distribution licensees shall connect net metering consumers in its distribution license area on a first-come, first-serve principle until any limits envisaged in clause 4.8.3.2 are reached.

4.8.4 Licensing

Net metering customers are required under the Act to obtain a generation license/ permit but will be exempted from paying license fees.

4.8.5 Grid Interconnection and Operations

4.8.5.1 The interconnection and operation of net metered installations shall be in accordance with the Distribution Network Code under the Zambian Distribution Grid Code

a). all single-phase net metered installations with a main circuit breaker rating of 60 A (Ampere) and less shall be classified as a small renewable in-feed (SRI) customer;

b). all other net metered installations shall be classified as embedded generation.

4.8.5.2 Distribution licensees shall endeavor to expedite the interconnection process for SRIs. For this purpose distribution licensees shall make use of the Standard Net Metering Application Form for SRIs and Standard Net Metering Interconnection Agreement annexed to this code.

4.8.5.3 The maximum response times for the Distribution licensee for net metered installations are as contained in the ZS 397.

4.8.5.4 All net metered installations shall comply with the provisions in the Zambian distribution grid code and other applicable standards.

4.8.5.5 A net metering facility shall be capable of operating in parallel and safely commencing the delivery of power into the distribution network at a single point of interconnection. To prevent a net metering customer from back-feeding a de-energized line, a net metering facility shall have a visibly open, lockable, manual, disconnect switch, which is accessible by the distribution licensee and clearly labeled. This requirement for a manual disconnect switch shall be waived if the following three (3) conditions are met:

a). The generation system must be designed to shut down or disconnect and cannot be manually overridden by the customer upon loss of utility power;
b). The generation system must be warranted by the manufacturer to shut down or disconnect upon loss of utility power; and
c). The generation system must be properly installed and operated, and inspected and/or tested in the presence of the distribution utility personnel.

4.8.5.6 Meters for net metered installations must:

a). Be at least a meter capable of measuring electricity flow in forward and reverse directions in 2 separate measuring units registers;
b). Be as prescribed by the distribution network licensee subject to the approval of the ERB;
c). Comply with all the meter standards in the ZS 647;
d). Not be of the pre-paid type.

4.8.5.7 Quality of electricity supplied from and to the net metered installation shall be in accordance with ZS 387 and ZS 397.

4.8.5.8 Distribution licensees shall install power quality measurement points at strategic locations close to distributed generation concentration areas, when required and in accordance with ZS 387.

4.8.5.9 The installation and maintenance of net metered installations must only be performed by competent personnel registered with Engineering Institution of Zambia.

4.8.6 Tariffs, Compensation and Billing

4.8.6.1. A DNSP shall provide to net metering customers electricity services at non-discriminatory rates that are identical with respect to rate structure, retail rate components, and any monthly charges, to the rates that a net-metering-customer would be charged if not a net-metering-customer, including choice of retail tariff structures.

4.8.6.2. Net-metering-customers shall be obliged to pay any interconnection costs associated with their installation. These costs shall be assessed on a non-discriminatory basis with respect to other customers with similar load characteristics. The connection charge methodology shall be in compliance with ERB tariff setting guidelines.

4.8.6.3. Net-metering-customers shall receive capacity compensation charges at the avoided capacity cost of the distribution utility if the generation facility can, with a 99% degree of certainty, contribute towards meeting the daily peak demand in the distribution utility's license area. The methodology of calculation and the avoided cost rate must be included in the tariff approval process of the ERB.

4.8.6.4. The compensation methodology for net exports by net-metering-customers shall be perpetual rollover.

4.8.6.5. Electrical energy exports by net-metering-customers to distribution networks up to the amount of electrical energy imports during the same billing period shall be valued at:

a). If the net-metering-customer is not on a time-of-use (TOU) tariff structure, the distribution utility's average avoided energy cost;
b). If the net-metering-customer is on a time-of-use (TOU) tariff structure, the distribution utility's TOU avoided energy costs;

4.8.6.6. The billing and reconciliation procedures and conditions for perpetual rollover of excess generation/net exports shall be:

a). On a monthly basis a net-metering-customer shall be billed the charges applicable under the currently effective standard rate schedule and any other appropriate tariff structures approved by the ERB. Under net metering, only the charges relating to the kilowatt-hour (kWh) units (energy part) of a customer's bill are affected.

b). If the net exports of a net-metering-customer is negative (the net-metering-customer is a net importer) during the monthly billing period, the net-metering-customer shall be billed for the Energy supplied to the distribution utility in accordance with the rates and charges under the customer's standard rate schedule and the net-metering-customer shall be paid for its exports in accordance with clause 4.8.6.5.

c). If the net exports of a net-metering-customer is positive (the net-metering-customer is a net exporter) during the monthly billing period, the net-metering-customer shall be billed for the energy supplied by the distribution utility in accordance with the rates and charges under the customer's standard rate schedule and the net-metering-customer shall be paid for its exports, up to its imports during the same billing period, in accordance with clause 4.8.6.5.

d). The net exports shall be paid to the next monthly billing period.

e). Any such credited excess kWh will not be physically compensated by the electricity distribution licensee; rather any credits will be carried over in perpetuity and allow the net-metering-customer to offset any future electricity purchases from the electricity utility using these credits.

4.8.6.7. All tariff applications, adjudications, and revisions will be conducted in line with the standard procedures of the ERB.

4.8.6.8. Distribution utilities are not allowed to estimate the electricity consumed and generated by net metered net-metering-customers during any billing period; the meters of net metered net-metering-customers must be read by both parties for every billing period.

4.8.6.9. Net-metering-customers must ensure that the meter is easily accessible and clearly marked in order to allow distribution utilities to read the meter. Customer generators must grant distribution utilities access to their property at least once a month for the purpose of maintaining and/or reading their meter.

4.8.6.10. Where a net-metering-customer vacates any premises where a net-metering installation is installed and terminates or transfers the corresponding contract, no refund for any remaining credit will be made to the net-metering-customer by the distribution licensee. On termination or transfer of the contract with the customer generator, either party shall be liable to pay for any outstanding credits.

4.8.7 Monitoring and Control

4.8.7.1. All distribution licensees shall report annually to the ERB on the progress on the implementation of net metering systems in their distribution license areas.

4.8.7.2. All distribution licensees shall develop and maintain a register of net metered net-metering-customers in their distribution license areas. The register shall be updated at least once a year and submitted annually to the ERB.

4.8.7.3. The register of net metered net-metering-customers must at least contain the following:

a). Net metered customers' names;
b). The total number of net metered customer facilities, by resource type;
c). The individual and total rated generating capacities of net metered customers' generator facilities, by resource type;
d). The individual and total annual number of kWh received from net metered customers, provided that this does not require additional metering equipment; and
e). The total estimated annual amount of kWh produced by net metered customers; provided that this estimate does not require additional metering equipment.

4.8.8 Carbon Credits

Distribution licensees and net-metering-customers shall consult with the ERB, the designated departments under the Ministries responsible for environment, finance, environment and energy with a view to ensure that the responsibility for realizing carbon credits and the equitable distribution of such benefits taking into consideration that the carbon credits belong to net-metering-customers, is assigned to entity(ies) capable of undertaking the associated transactional costs and effort.

4.8.9 Third Party Ownership and Aggregation of Electricity Accounts

Third party ownership of net - metered installations, as well as the aggregation of many electricity accounts to one or more net-metered installations, are only allowed after written approval from the ERB.

5. INFORMATION EXCHANGE CHAPTER

5.1. Objectives

5.1.1. To define the reciprocal obligations of *participants* with regard to the provision and exchange of planning, operational and maintenance information for the implementation of the *Distribution Grid Code*.

5.1.2. Information exchanged between participants governed by this code shall not be confidential, unless otherwise stated.

5.2. Scope of Application

5.2.1. The participants to whom the Distribution Information Exchange Code shall apply are:

a). DNSPs
b). Retailers
c). Embedded Generators
d). End-use customers
e). Resellers

5.2.2. Information requirements specified in the other codes within the Distribution Grid Code are supplementary to this code. In the event of inconsistencies between other codes and the Information Exchange Code with respect to information exchange, the requirements of the Information Exchange Code shall take preference.

5.3. Information Exchange Interface

5.3.1. The parties shall identify the following for each type of information exchange:

a). The name and contact details of the person(s) designated by the information owner to be responsible for provision of the information
b). The names, contact details of, and the parties represented by persons requesting the information
c). The purpose for which the information is required
d). The parties shall agree on appropriate procedures for the transfer of information.

5.3.2. Participants (with installed capacity of more than 100kVA) shall exchange information, prior to commissioning, of new or altered equipment connected at the point of connection or changes to the operational regimes that could have an adverse effect on the DS to enable proper modifications to any affected participants networks and related systems.

5.4. Provision and exchange of Information during the planning and connection process

Each *DNSP* shall have a *supply application form*, which shall request, at minimum, the information stipulated in this section.

5.4.1. Customers requesting supply at low voltage shall provide the DNSP with the information relating to:

a). New or change in connected loads
b). Type of load to be connected to the *Distribution System*
c). Requested connection date
d). Proposed network point of connection address.

5.4.2. Customers requesting supply at HV/EHV or MV shall, in addition to 5.4.1 above, provide the DNSP with the following information:

a). Requested supply voltage
b). Expected and / or projected maximum demand (in kVA)
c). Expected load power factor
d). Switched customer capacitor banks and reactors, which could affect the Distribution System
e). Whether the load is capable of producing Harmonics as specified by equipment manufacturers
f). The nature and type of process the supply is requested for
g). Minimum required fault levels
h). Start-up requirements
i). Whether the customer has any standby generator.

5.4.3. The DNSP may request Customers to provide information on the Customer's proposed installation and equipment at the Point of Connection.

5.4.4. Participants shall exchange information relating to the protection of Distribution System and customer equipment protection coordination at the point of connection.

5.4.5. Upon any reasonable request, the DNSP shall provide customers or potential customers with any relevant information that they require to properly plan and design their own networks/installations. This may include but not limited to:

a). Nominal voltage at which connection will be made
b). Method of connection, extension and/or reinforcement details
c). The maximum and minimum fault levels
d). Method of earthing
e). Maximum installed Capacity at the point of connection

f). Specification of any accommodation of equipment requirement

g). Individual customer limits relating to:

  i). Harmonic Distortion

  ii). Voltage Flicker

  iii). Voltage Unbalance

h). Expected lead time of providing connection (following formal acceptance of terms for supply) as per ZS 397

i). An indication of network single contingency capability

j). An indication of current network performance and power quality

k). Cost of connection

l). Range of current approved tariff structures

5.5. Operational Information

5.5.1. Commissioning and notification

5.5.1.1. *Customers* shall confirm that all information given in the application for supply and additional information subsequently requested by the *DNSP* is correct before the commissioning.

5.5.1.2. The commissioning dates shall be negotiated between the *parties. Participants* will agree on the type of operational data to be submitted prior to commissioning, which shall include test and commissioning report.

5.5.1.3. The asset owner (*DNSP or Customer*) shall ensure that all equipment records, that affect the integrity of the *Distribution System* or relevant to the interconnection, are maintained for reference for the duration of the operational life of the plant. On request from the *DNSP*, information shall be made available within a reasonable time.

5.5.1.4. The *DNSP* shall indicate to the *customer* what information is relevant in terms of this section.

5.5.2. Sharing of Assets and Resources

DNSPs sharing assets and resources shall enter into agreements for the provision and sharing of their assets, resources, services and information.

5.5.3. Additional Information Requirements

Should one *participant*, acting reasonably*,* determine that additional measurements and/or indications are needed in relation to another *participant's* plant and equipment; the requesting *participant* shall consult with the affected *participant(s)* to agree on the manner in which the need may be met. The costs related to the modifications for the additional measurements and/or indications shall be for the account of the causal *participant*.

5.5.4. Communication and Liaison

5.5.4.1. *Participants* shall establish a communication channel for exchange of information required for distribution operations, which may include the installation of DNSP's remote monitoring and control equipment at the *customer's* or *DNSP's* installation to facilitate the flow of information and data to and from the *DNSP* and / or Transmission control facilities.

5.5.4.2. Each *participant* shall designate a person with delegated authority to perform the duties of *information owner* in respect of the granting of access to information covered in this code to third parties. A party may, at its sole discretion, designate more than one person to perform these duties.

5.5.4.3. The *DNSP* shall take reasonable steps to exchange information with the *DNSP's* affected *customers* for *DS* and *TS* outages.

5.5.4.4. *Customers* shall exchange information with the *DNSPs* within an agreed lead time on all operations on their installations which may have an adverse effect on the *Distribution System* including any planned activities such as plant shutdown or scheduled maintenance.

5.5.4.5. The communication facilities standards shall be set and documented by the *DNSP*. Any changes to communication facilities standards impacting on *participant* equipment shall be brought to the attention of the *participant* well in advance of the proposed upgrade.

5.5.4.6. Any back up or emergency communication channels established by the DNSP and deemed necessary for the safe operation of the Distribution System shall be agreed upon by the DNSP and the participant affected.

5.5.5. Data Storage and Archiving

5.5.5.1. The obligation for data storage and archiving shall lie with the *information owner*.

5.5.5.2. The systems that store the data and/or information to be used by the *participants* shall be of their own choice and for their own cost.

5.5.5.3. All data storage systems must be able to be audited by the ERB. The 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 *parties*.

5.5.5.4. The *information owner* shall keep all information, except voice recorded information, in its original format for a period of at least five (5) years (unless otherwise specified differently in other parts of this code) commencing from the date the information was created.

5.5.5.5. *Participants* shall ensure reasonable security against unauthorized access, use and loss of information for the systems that contain the information.

5.5.5.6. *DNSPs* shall use a voice recorder for historical recording of all operational voice communication with *participants*. These records shall be available for at least three (3) months except where there is an incident involved, in which case the requirements of any applicable legislation shall apply. The *DNSP* shall make the voice records of an identified incident in dispute available within a reasonable time period after such a request from a participant and/or the ERB.

5.5.5.7. An audit trail of all changes made to archived data should 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.

5.6. Confidentiality of information

5.6.1. Information exchanged between *participants* governed by this code shall not be confidential, unless otherwise stated.

5.6.2. *Participants* receiving information shall use the information only for the purpose for which it was supplied.

5.6.3. The *information owner* may request the receiver of information to enter into a confidentiality agreement before information, established to be confidential, is provided.

5.6.4. Confidential information shall not be transferred to a third party without the written consent of the information owner. *Parties* shall observe the proprietary rights of third parties for the purposes of this code. Access to confidential information within the organizations of parties shall be provided as reasonably required.

5.6.5. The *participants* shall take all reasonable measures to control unauthorized access to confidential information and to ensure secure information exchange. *Parties* shall report any leak of information that is governed by a confidentiality agreement as soon as practicable after they become aware of the leak, and shall provide the information owner with all reasonable assistance to ensure its recovery or destruction (as deemed appropriate by the information owner).

6. TARIFF CHAPTER

6.1. Introduction

6.1.1. This chapter sets out the objectives for *pricing and tariff structures for distribution retail and network services.* The ERB shall regulate the setting of prices and the structure of tariffs for all distribution related services.

6.1.2. *Service-providers* shall therefore be regulated on the prices and tariff structures they may charge *customers*.

6.1.3. *Customers* and the *service provider* shall *contract* with each other for the payment of charges related to *distribution* services. These charges shall reflect the different services provided the standard applicable tariff, standard charges as well as any non-standard charges. These shall be explained by the *service provider* on request.

6.2. Scope

6.2.1. The *tariff chapter* applies to all regulated *tariff structures* (components and levels) and negotiated pricing agreements under the jurisdiction of the ERB (governed by the relevant legislation and national policy) including international pricing agreements impacting prices for local customers.

6.2.2. The determination of the revenue requirement is managed by a process and rules set by the ERB. The ERB shall determine a methodology for regulation of distribution tariff, currently not dealt with in this code.

6.2.3. The tariff code applies to the following generic retail charges:

a). Energy charges
b). Network charges, including ancillary services
c). Customer services charges

6.3. Objectives

6.3.1. To outline the process for the design of the *Distribution* tariffs, this shall be achieved taking cognisance of the following:

a). Meeting customer requirements.
b). Tariffs and connection charges should provide the means to recover the regulated revenue requirement in the most cost effective way so that the business is financially viable and customers can receive an acceptable level of service.

c). Tariffs should promote overall demand and supply side economic efficiency, and be structured to encourage sustainable, efficient and effective usage of electricity.

d). Tariffs should recover the cost of customers' current capacity and usage.

e). Tariffs should be non-discriminatory and transparent subject to the specific tariff qualification criteria. The following principles shall apply:

  i). *Network tariffs* should be relative to the utilisation of the networks and not be dependant on what the *customer* uses the network capacity for

  ii). It should be clear to *customers* how these prices are determined

  iii). Where cross-subsidies exist between *customers,* they should be justifiable and where quantifiable explicitly identified.

6.3.2. Tariff rates and structures should accurately reflect the cost to supply different tariff categories. Where prudent, tariff structures should reflect the underlying cost structure.

6.3.3. Tariffs should reflect the ring-fenced cost of retail and network services where this can be accommodated.

6.3.4. There should be stability and predictability in tariffs in order to facilitate customer choices.

6.3.5. There should be an optimal range of tariffs based on usage patterns to, as practically as possible, meet customers' requirements.

6.3.6. Tariffs should be simple, transparent and understandable to the relevant target customer base.

6.3.7. Customers should be charged connection charges for the cost of providing required capacity as prescribed in ZS 397 and/or any other relevant ERB approved documents

6.3.8. Where objectives are in conflict with each other, the ERB will achieve an optimal balance through regulation. Where service providers are unable to meet all of the above objectives, they shall be required to prioritise and motivate the above objectives based on their specific economic and social circumstances.

6.4. Principles for the determination of tariffs

6.4.1. General

This section sets out the principles to be applied to the application and development of *distribution network* and retail tariffs. These principles are divided into two areas –

principles associated with the allocation of costs for tariff design and principles associated with tariff design:

6.4.1.1. Principles for the allocation and recovery of costs in tariffs

6.4.1.1.1. *Tariffs* should recover current regulated revenue requirement but may reflect future cost drivers in their structure to provide clear *pricing* signals to the customer, that promote economic efficiency.

6.4.1.1.2. Costs shall typically be differentiated on the following; capacity, voltage, load factor, load profile, density and geographic location.

6.4.1.1.3. Each DNSP's electricity costs (including purchases) must be ring fenced from other non-electricity related costs.

6.4.1.1.4. Network charges for loads will reflect costs allocated to pooled voltage levels, density and geographic location where relevant. The customer grouping for pooling and therefore averaging of costs must be justifiable, such that it ensures sustainable approved cross-subsidies (Cost pooling (aggregation and averaging of costs) is required due to practical reasons).

6.4.1.1.5. Costs to provide a quality of supply as determined by the ERB (based on ZS 387 and other ERB's directives on quality of supply standards) will be recovered through tariffs and standard connection charges.

6.4.1.1.6. The cost of a higher quality of supply not justified in terms of the investment criteria in the Network Code to meet specific requirements at the customer's request shall be provided at an additional dedicated cost to the customer.

6.4.1.2. Principles for design of tariffs

6.4.1.2.1. The *DNSP* shall make capacity available on its networks and provide open nondiscriminatory access for the use of this capacity to all *Zambian Customers (loads)*, and *Embedded Generators*. In exchange for this service, the *DNSP* is entitled to a fair compensation through electricity tariffs.

6.4.1.2.2. A stakeholder consultative process should be followed in the design and approval of tariffs.

6.4.1.2.3. The structure of tariffs (the balance of fixed and variable components) should reflect the costs drivers.

6.4.1.2.4. Tariff charges (including energy costs) will not be based on customer specific assets or services, but aggregated and averaged based on justifiable pooled costs.

6.4.1.2.5. The components that make up a tariff structure will be aggregated and averaged to a lesser or greater degree depending on the tariff category being served.

6.4.1.2.6. Tariff structures should contain pricing signals that promote energy efficiency (for example, DSM) and efficient use of network resources.

6.4.1.2.7. International end-use customers connected to the distribution system will be charged standard network charges and will pay connection fees.

6.4.1.2.8. The contribution to the government funded programmes such as cost of free basic electricity and the electrification programmes funded by government shall not be recovered through electricity tariffs.

6.4.1.2.9. Connection charges will recover that portion of the full cost of dedicated assets and the approved standard scheduled capital contribution to shared upstream assets, not recovered by the tariff.

6.5. Governance and communication process

6.5.1. The *ERB* shall be required to evaluate and approve all tariff structure applications for new tariffs or changes to existing structures. This includes non-standard negotiated tariffs.

6.5.2. *DNSPs/Service-providers* shall ensure that the consultative process is followed with stakeholders on proposed and approved changes to tariffs.

6.5.3. *DNSPs/Service providers* shall submit and justify their methodology for determination of distribution retail and network service tariffs to the *ERB* prior to approval of the *tariffs*.

6.5.4. *DNSPs/Service-providers* shall charge only *ERB* approved tariffs.

6.5.5. *DNSPs/Service-providers* shall publish their approved schedule of standard tariffs.

6.6. Segmentation of costs for tariff design purposes

For tariff design purposes, the ring fenced electricity revenue requirement of a *DNSP* shall typically be segmented into the following categories as per an accepted cost allocation methodology.

a). Purchase costs

These are pass-through costs as charged by *generators* and the *transmission network service provider(s)* and if applicable a distribution service provider. The tariffs charged and the rules applicable to these services are separately regulated and the *DNSP/service provider* is a price-taker for these costs, these costs comprise:

i). Energy
ii). Transmission services
iii). Distribution services

b). Distribution costs

i). Allowed annual interest and depreciation on invested capital employed to provide the existing network. The interest and depreciation cost are reflected in the revenue requirement of the utility for the regulatory period.
ii). Allowed operations and maintenance costs.
iii). Regulated return on assets.
iv). Other allowed costs (including overheads).
v). Technical and non-technical losses

c). Retail costs.

i). Allowed costs
ii). Retail margin

6.7. Cost reflective tariff structures

6.7.1. Tariff structures should reflect cost drivers as far as possible. Where tariff structures do not reflect costs, there is risk associated with mismatching of costs, tariff conversions and changes in volume forecast. The DNSP/service provider shall be allowed to mitigate this risk, through appropriate tariff or claw-back mechanisms (for both under or over recovery of revenue) within the revenue requirement.

6.7.2. The tariff charges (rates) shall be calculated based on the approved revenue requirement, volume forecast for demand and energy and customer numbers. At the end of each revenue review period, the ERB may audit and verify the tariff charges (rates) calculations and results.

6.7.3. In order to design fully cost-reflective tariff structures for a *DNSP/service provider*, electricity supply costs must be unbundled into energy purchases, network (transmission purchases and distribution costs) and retail /service components.

6.7.4. A cost-reflective tariff structure will:

a). Align with the purchase structure and cost of energy.
b). Align with the transmission network purchasing structure.

c). Reflect the provision of access to and usage of distribution networks through network charges.

d). Include differentiation to take into account:

i). Time and /or seasonal variance.
ii). The voltage of the supply.
iii). The electrical (technical) losses associated with the applicable customer category.
iv). Power factor of the supply.
v). The density of customers and geographic location of the network to which customers are connected.
vi). Load factor.
vii). Load profile.
viii). Retail charges that reflect the size of the supply and the services being provided to the customer.

6.7.5. The tariff structure ultimately used will depend on customer needs, meter capability, billing functionality and logistics, and limitations on tariff complexity. This will cause aggregation of various cost components and cost drivers in the tariff applied. Fully cost reflective tariff structures are based on unbundled costs.

6.8. International load customers

6.8.1. International customers connected to a distribution network (excludes all SAPP contracts), will pay the regulated retail *tariffs*, including all applicable subsidies as Zambian customers.

6.8.2. International customers will be required to pay connection charges that reflect all upstream investments required to provide supply, either as actual costs or a fair contribution to shared upstream networks.

6.8.3. The financing of connection assets for international customers will be in accordance with the risk policy of each DNSP.

6.9. Non-tariff costs (excluded services costs)

6.9.1. Excluded services are those services requested by individual that are generally excluded from the regulated rate base and may or may not be competitive.

6.9.2. Where excluded service is a monopoly services, such charges may be regulated.

6.10. Connection charges

6.10.1. General

6.10.1.1. This charge is payable in addition to the tariff charges and is payable on all dedicated costs plus a fair contribution to capacity on upstream networks.

6.10.1.2. Connection charges may be regulated and are excluded from the regulated asset base.

6.10.1.3. The methodology used to calculate connection charges must be approved by the ERB.

6.10.1.4. In addition to the *DNSP's* costs, the *DNSP* shall be liable to the *TNSP* for any dedicated costs in the event the Transmission System require modifications in order to connect a *DNSP*-customer to the *Distribution System*. If this cost is dedicated to a customer, then the transmission connection charge will be passed through to that customer.

6.10.2. Standard connection

6.10.2.1. A *standard connection* is defined as the lowest *life-cycle* costs for a technically acceptable solution as per the investment criteria in the Network Chapter.

6.10.2.2. All *customers* requiring a new connection or additional capacity for an existing connection shall pay a *connection charge* which may be rebated as per paragraph 6.10 of this section.

6.10.2.3. The *connection charge* for a basic connection is a set connection fee and shall be approved by ERB.

6.10.2.4. A *basic standard connection* is a connection to supply a basic electricity supply to a residential customer with a pre-determined connection charge.

6.10.2.5. For all standard connections that are not basic connections, connection charges will be based on dedicated network costs plus shared network costs less the capital allowance rebate in the tariff.

6.10.2.6. For all connections a DNSP shall provide a connection as defined in the investment section 2.8.2 of the Network Chapter and where applicable shall rebate such costs one-off by the amount of capital as allowed by the ERB.

6.10.2.7. A *standard connection* charge covers the cost of dedicated network costs plus a contribution to shared network costs less the capital allowance rebate in the tariff.

6.10.2.8. The *connection charge* may be paid by way of an upfront payment by the *customer* or if financed by the *DNSP* by way of a minimum upfront *connection fee* and a monthly *connection charge*.

6.10.2.9. The standard connection charge will be based on costs allocated as per the approved methodology where:

a). The customer pays for all dedicated costs. Dedicated costs are the cost of those assets that are unlikely to be shared in the DNSP's planning horizon by any other end-use customer.
b). Dedicated costs will be based on the investment to meet the customer's capacity requirements at the minimum technical standards, as stipulated in the Network Code.
c). Surplus capacity provided due to technical standards that may be shared in the near future will not be allocated as a connection cost to the customer. The cost of surplus capacity provided due to technical requirements and that will not be shared in future (for example, the provision of a 20 MVA transformer to meet a 15 MVA load), will not be pro-rated.
d). Dedicated assets later shared result in a refund/reduction to the initial contributor only based on capacity. Adequate records must be kept.
e). In addition to dedicated costs the customers shall be allocated a standard ZMW/kVA contribution based on replacement costs, for shared upstream costs, whether new upstream investment is required or not.
f). For standard connection assets, the cost of depreciation, operations, maintenance and refurbishment cost will be recovered through the revenue requirement, as allowed by the ERB.

6.10.3. Premium connection

6.10.3.1. A *premium connection* charge is raised where a customer contracts with the *DNSP* for additional specific requirements not justified in the investment criteria in section 2.8.2 of the Network Code.

6.10.3.2. The *premium connection* charge may be paid by way of a one-off upfront payment by the *customers* or by way of a connection fee and a monthly *connection charge* if the *DNSP* provides financing. The *premium connection fee* shall be a minimum of 100% of the allocated additional costs.

6.10.3.3. The *premium connection* charge will be based on all costs associated with providing the *premium connection* including all dedicated and upstream strengthening costs. *Premium connection charges* will not be rebated by any capital allowance.

a). For dedicated premium connection assets, the cost of refurbishment shall not be recovered through the revenue requirement but shall be recovered directly from the customer.

b). The customer will be required to pay the costs of refurbishment of connection assets not justified in terms of the investment criteria specified in Section 2.8.2 of the Network Code.

c). The cost of maintenance and operations of premium assets shall be recovered from the regulated revenue requirement, unless specifically contracted between the DNSP and the customer.

7. GRID INTEGRATION OF RENEWABLE ENERGY BASED POWER PLANTS

7.1 Objectives

Renewable energy systems have become one of the widely adopted alternative sources of electricity. This chapter sets out the minimum technical requirements for connection of renewable energy based power plants (RPPs) to the distribution system in order to ensure efficient and coordinated development, operation and maintenance of RPPs in the distribution system.

It establishes the basic rules, procedures, requirements and standards that govern the operation, maintenance, and development of the RPPs in Zambia to ensure the safe, reliable, and efficient operation of the distribution system in Zambia.

The primary objective of this chapter is to promote sound planning, operational and connection standards in a bid to provide for reliable, secure, safe, economic and coordinated operation of the RPPs connected to or seeking connection to the distribution system. This will be achieved through the following:

a). Specification of minimum technical requirements
b). Specification of minimum safety standards
c). Specification of minimum operational standards
d). Specification of information requirements and procedures

This chapter shall be used together with other applicable requirements of this code (i.e. applicable Zambian standards, Grid Code etc.) as compliance criteria for RPPs connected to the Distribution System.

7.2 Scope

7.2.1. The grid connection requirements in this chapter shall apply to the SO, respective DNSPs and all RPPs connected or seeking connection to the DS.

7.2.2. The requirements shall, at minimum, apply to the following RPP technologies:

a). Solar Photovoltaic (PV)
b). Small Hydro
c). Biogas
d). Wind
e). Thermal RPPs such as Geothermal, Concentrated Solar Power and Biomass

7.2.3. Unless otherwise stated, the requirements in this code shall apply equally to all RPP technologies and categories.

7.2.4. The RPP shall, for the duration of its generation licence issued by the ERB comply with the provisions of this code and all other applicable codes, rules and regulations approved by the ERB.

7.2.5. Where there has been a replacement of or a major modification to an existing RPP, the RPP shall be required to demonstrate compliance to these requirements before being allowed to operate commercially.

7.2.6. Compliance with this and other codes requirements will depend on the interaction between the RPP and the grid to which it is connected. The DNSP shall supply the RPP Generator with a reasonable detail of their DS that is sufficient to allow an accurate analysis of the interaction between the RPP and DNSP, TNSP, and other generation facilities.

7.3 Grid Connection Requirements

These requirements apply to all RPPs that require grid integration. It outlines the minimum technical, design and operational criteria to be met by RPPs seeking to be synchronised to the distribution grid system.

7.3.1 Grid Impact Studies

7.3.1.1. The DNSP shall conduct Grid Impact Studies to evaluate the impact of the proposed connection or modification to an existing connection on the grid system as required by the Zambia Grid Code and this code for connections greater than 100kVA.

7.3.1.2. All connection requirements at the point of connection shall be funded by the RPP.

7.3.1.3. All system-wide works required resulting from the connection of the RPP shall be borne by the network operator.

7.3.2 Commissioning of Equipment

7.3.2.1. Upon completion of all works, including work at the Point Of Connection, the equipment at the Point Of Connection and the RPP shall be subjected to the Testing and Commissioning procedure as set by the DNSP.

7.3.2.2. The physical connection to the grid system shall be made only after the DNSP is satisfied with the test and commissioning procedures conducted.

7.3.2.3. A certificate of approval to connect shall be issued to the RPP by the DNSP.

7.3.3 Synchronizing Facilities

7.3.3.1. The generating facility shall have synchronizing facility for each unit connected to the Grid system.

7.3.3.2. The facility shall consist of a synchronizing relay and a sync-check relay. The settings on these relays shall be submitted to the System Operator for review to insure that they will not adversely affect the operation of the Grid System.

7.3.4 Voltage Variations

7.3.4.1. RPP projects shall be designed in such a way that they do not adversely affect the voltage variation at the point of connection.

7.3.4.2. AC voltage and frequency ratings to be compatible with ZS 387.

7.3.4.3. The voltage variations shall not exceed the limits of the stated connection voltage during normal operating conditions as stated in ZS 387.

7.3.4.4. The RPP shall be designed to withstand sudden phase jumps of up to 20° at the POC without disconnecting or reducing its output. The RPP shall after a settling period resume normal production not later than 5 sec after the operating conditions in the POC have reverted to the normal operating conditions.

7.3.4.5. The plant shall be designed and operated to include devices that will withstand and mitigate the effects of transient over voltages on the distribution system.

7.3.4.6. Solar PV inverters shall be designed in accordance with the relevant IEC standard or an internationally recognised equivalent.

The DC content of the output current of the inverter at the AC terminals shall not exceed 0.5% of its rated output nominal current.

The inverter must disconnect within 3 seconds when the average voltage for a 10 minute period exceeds the maximum nominal operating voltage.

7.3.4.7. All RPPs shall be equipped with a voltage regulator with the capability of operating continuously while maintaining a voltage between 0.90 pu and 1.10 pu of the rated generator voltage at the interconnector bus from no-load to full-load.

7.3.4.8. The rated power output of a generating unit shall not be affected by voltage changes within the limits declared at the point of connection.

7.3.5 Frequency Variations

7.3.5.1. The nominal fundamental Frequency shall be 50 Hz. In case the system frequency momentarily rises above limits set in the Grid Code, all generating units shall remain in synchronism with the grid and shall operate normally between these limits for at least five (5) seconds to allow the System Operator to undertake measures to correct the situation.

7.3.5.2. For solar PV inverters:

a). If grid frequency exceeds 52.5 Hz, the inverter current shall reduce until 51.5Hz is reached at which point inverter current reduction must stop.

The current can be increased when grid frequency has decreased to 50.05 or less.

b). The inverter must disconnect within 3 seconds when the average frequency for a 1 minute period exceeds 52.5Hz.

7.3.6 Reactive Power and Voltage Control

7.3.6.1 The majority of DNSP's Networks bulk substation transformers are fitted with on-load tap changing (OLTC) facilities and will automatically act to restore network voltage levels within minutes. In addition, Line Drop Compensation (LDC) controls may also be used to regulate the network voltage at a location downstream of the bulk substation. These controls are commonly used to regulate network voltages and maximise transfer capacity to customers.

7.3.6.2 The connection of embedded generators to the distribution network may impact on the DNSP's ability to regulate network voltages. For this reason, DNSPs requires embedded generating systems to control reactive power output, within their capability, to maintain the point of connection voltage to an agreed target or operate at an agreed power factor such that voltage variations are maintained within prescribed limits. The DNSPs shall be able to monitor both active and reactive power generation by the RPPs at POC point of connection.

7.3.6.3 RPPs shall be designed with the capability to operate in a voltage, power factor or, reactive power (Q or MVAr) control modes. The actual control operating mode (V, power factor or Q control) as well as operating point shall be agreed with the DNSP and the SO.

7.3.6.4 The RPP shall be equipped with reactive power control functions capable of controlling the reactive power supplied by the RPP at the POC as well as a voltage control function capable of controlling the voltage at the POC via orders using set points and gradients for the specified parameters.

7.3.6.5 The control functions for the supply of a specific reactive power, power factor and voltage control are mutually exclusive, which means that only one of the three functions can be activated at a time.

7.3.6.6 The control function and applied parameter settings for reactive power and voltage control functions shall be determined by the DNSP in collaboration with the SO, and implemented by the RPP generator. The agreed control functions shall be documented in the operating agreement.

7.3.7 Power Quality

7.3.7.1 Harmonics

7.3.7.1 The generator shall ensure not to cause Harmonics in the Grid System that exceed specified limits.

7.3.7.2 The Total Harmonic Distortion of the voltage and the Total Demand Distortion of the current, at any Point Of Connection, shall not exceed the limits prescribed in ZS 387.

7.3.7.2 Voltage Unbalance

7.3.7.1. The RPP shall ensure that its plant does not cause Voltage Unbalance in the Grid System.

7.3.7.2. The maximum Voltage Unbalance at the Point of Connection shall not exceed the limit specified in ZS 387 during normal operating conditions.

7.3.7.3. The phase voltages of a 3-phase supply should be of equal magnitude and 120° apart in phase angle. Voltage unbalance is defined as:

$$Voltage\ Unbalance = \frac{Deviation\ between\ highest\ and\ lowest\ \ phases}{Average\ voltage\ of\ three\ phases}$$

7.3.7.4. The RPP must be able to withstand the effect of voltage unbalances resulting from system disturbances such as unbalanced power line faults.

7.3.7.5. The RPP shall also be required to withstand without tripping, the unbalance loading during clearance by the Backup Protection of a close-up phase-to-phase fault on the Grid System.

7.3.8 Active Power Control

RPPs must be equipped with active power control functions capable of controlling the active power supplied by the power plant at the POC using activation orders containing set points.

7.3.8.1. Active Power Control Functions

7.3.8.1.1. RPPs shall be capable of controlling the ramp rate of its active power output with a maximum MW per minute ramp rate set by SO, TNSP or DNSP as the case may be.

7.3.8.1.2. In case of variations in energy resources, the RPP shall design and ensure that the ramp rate of its generating units does not exceed the ramp rate capability of the regulating power unit(s).

7.3.8.1.3. These ramp rate settings shall be applicable for all ranges of operation including positive ramp rate during start up, positive ramp rate only during normal operation and negative ramp rate during controlled shut down. They shall not apply to frequency regulation.

For solar PV RPPs, in terms of power rate limit, the inverter should have the capability to limit the increase in power export to 10% of nominal rated capacity per minute. If the inverter has storage capabilities, it should also be able to limit the decrease in power export by 10% per minute.

7.3.8.1.4. The RPP shall not perform any frequency response or voltage control functions without having entered into a specific agreement to this effect with the DNSP.

7.3.8.1.5. In case of frequency deviations in the IPS, RPPs shall be designed to be capable to provide power-frequency response in order to stabilise the grid frequency.

7.3.8.1.6. During high frequency operating conditions, RPPs shall be able to provide mandatory active power reduction requirement in order to stabilise the frequency in accordance with the limits provided in ZS 387.

7.3.8.2. Active Power Constraints

For system security reasons it may be necessary for the SO, DNSP or their agent to curtail the RPP active power output.

7.3.8.2.1. The RPP generator shall be capable of:

a). Operating the RPP at a reduced level if active power has been curtailed by the SO, DNSP or their agent for network or system security reasons.

b). Receiving a telemetered MW curtailment set-point sent from the SO, DNSP or their agent. If another operator is implementing power curtailment, this shall be in agreement with all the parties involved.

7.3.8.2.2. The RPP shall be equipped with constraint functions, i.e. supplementary active power control functions. The constraint functions are used to avoid imbalances in the IPS or overloading of the IPS in connection with the reconfiguration of the IPS in critical or unstable situations or the like.

Activation of the active power constraint functions shall be agreed with the SO or DNSP.

The required constraint functions are as follows:

a). Absolute power constraint
b). Delta power constraint
c). Power gradient (Ramp rate) constraint

7.3.8.2.2.1 Absolute Power Constraint

a). An Absolute Power Constraint is used to constrain the output active power from the RPP to a predefined power MW limit at the POC. This is typically used to protect the IPS against overloading in critical situations.

b). If the set point for the Absolute Power Constraint is to be changed, such change shall be commenced within two seconds and completed not later than 30 seconds after receipt of an order to change the set point.

c). The accuracy of the control performed and of the set point shall not deviate by more than ±2% of the set point value or by ±0.5% of the rated power, depending on which yields the highest tolerance.

7.3.8.2.2.2 Delta Power Constraint

a). A delta power constraint is used to constrain the active power from the RPP to a required constant value in proportion to the possible active power.

b). A delta power constraint is typically used to establish a regulating reserve for control purposes in connection with frequency control.

c). If the set point for the Delta Power Constraint is to be changed, such change shall be commenced within two seconds and completed no later than 30 seconds after receipt of an order to change the set point.

d). The accuracy of the control performed and of the set point shall not deviate by more than ±2% of the set point value or by ±0.5% of the rated power, depending on which yields the highest tolerance.

7.3.8.2.2.3 Power Gradient (Ramp rate) constraint

a). A power gradient constraint is used to limit the maximum ramp rates by which the active power can be changed in the event of changes in primary renewable energy supply or the set points for the RPP, taking into account the availability of primary energy to support these gradients.

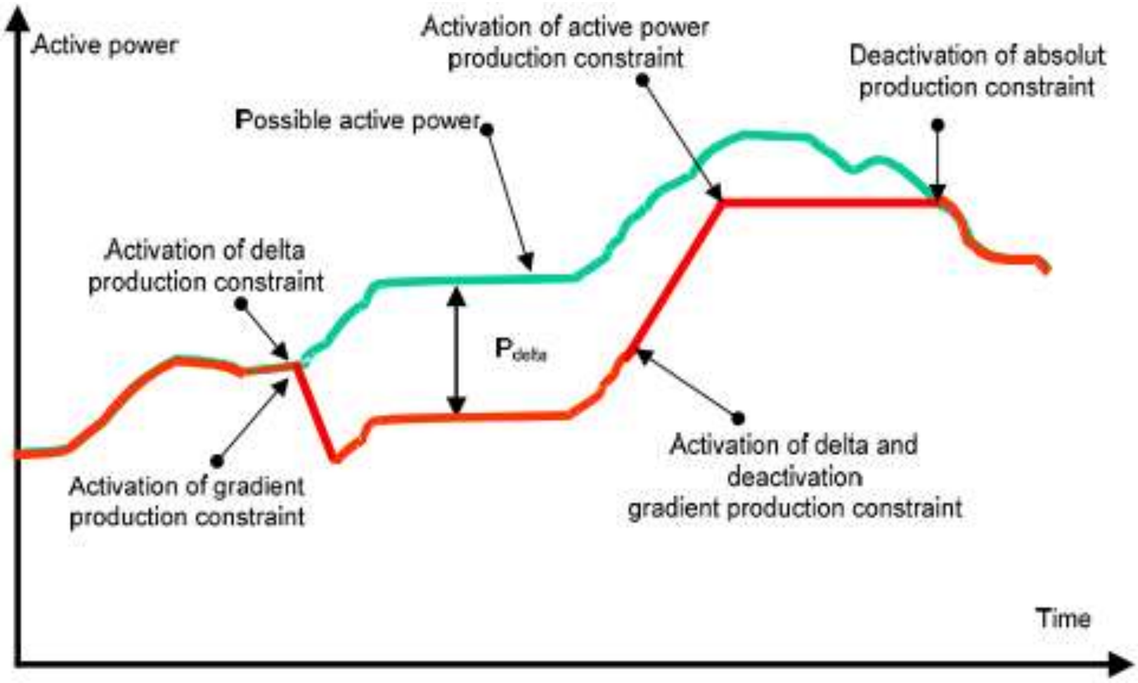
b). A power gradient constraint is typically used for reasons of system operation to prevent changes in active power from impacting the stability of the IPS.

c). If the set point for the power gradient constraint is to be changed, such change shall be commenced within two seconds and completed no later than 30 seconds after receipt of an order to change the set point.

d). The accuracy of the control performed and of the set point shall not deviate by more than ±2% of the set point value or by ±0.5% of the rated power, depending on which yields the highest tolerance.

The active power constraint functions are illustrated in Figure 7-1 below.

Figure 7-1: Active power control functions for a Renewable Power Plant



7.3.9 Black Start Capability

7.3.9.1. The Generator shall have a Black Start capability.

7.3.9.2. The System Operator, pursuant to the procedures in the Zambian Grid Code, shall be responsible in the resynchronization of the Island Grids after the Black Start procedure or after a significant incident has resulted in Island Grid operation.

7.3.10 Protection Requirements

The RPP shall at all times install and maintain protection installations that comply with the principles and specifications of this Chapter.

This is done in order to:

a). Ensure agreed power quality to customers
b). Minimise damage to primary plant
c). Prevent damage to healthy equipment that conducts fault current during faults
d). Limit safety hazard to the power utility personnel and the public.

7.3.10.1. General Protection Arrangements

7.3.10.1.1 The generator shall be designed and operated with protective devices in accordance with the requirements of the network operator.

7.3.10.1.2 The Fault Clearance Time shall be within the limits established by network operator in accordance with the protection philosophy.

7.3.10.1.3 The network operator and RPP shall be solely responsible for the protection system of the electrical equipment and facilities at their respective sides of the Point Of Connection.

7.3.10.2. Power Islanding

During Island Grid operation, a Solar PV generating unit providing Ancillary Services for Frequency Regulating Reserve shall provide Frequency Control to the Island Grid.

All generating facilities that cannot meet set frequency performance shall be equipped with protection systems, which detect a power islanding condition, and trip the RPP. This may require re-coordination with the grid system protection or the installation of special communication and protection schemes to send direct trips to the RPP.

If no facilities exist for the subsequent resynchronization with the rest of the grid system then the RPP shall ensure that the Generating Plant is disconnected for re-synchronization.

Under emergency conditions there is an expectation that some generation shall continue to operate outside the statutory frequency limits. However, for Embedded Generators connected to the distribution system at a voltage level less than 66 kV it is likely that this could mean connection within an automatic low frequency load disconnection zone.

Consequently, Embedded Generators should ensure that all Protection on Generating Plant should have settings to co-ordinate with those on the automatic low frequency load disconnection equipment in conformance with the requirements of the Zambian Grid Code.

7.3.10.3. Negative Sequence Voltage

Any generating unit or generating plant connected to the grid system shall be required to withstand, without tripping, the Negative Phase Sequence loading incurred during the clearance of a close-up phase –to-phase fault by system back-up Protection which shall be within the Plant short time rating on the distribution system.

The RPP must ensure that its generating unit’s contribution to the negative sequence voltage at the point of connection between the generating unit and the grid system is less than 1%.

7.3.10.4. Over Current and Earth Fault Protection

Every generator shall be equipped with over-current and earth fault protection to trip the generator off in the event of a fault.

7.3.10.5. Over and Under Frequency Protection

Every generator is required to have under and over-frequency protection relays that will disconnect the Generator from the grid System if the frequency is outside the limits as specified in ZS 387 of 48.75 - 51.25 Hz.

7.3.10.6. Over And Under Voltage Protection

Every generator shall have under and over-voltage protection relays which will disconnect the generator from the grid system in the event of abnormal voltages occurring on the grid system as stipulated in the grid and distribution grid code.

7.3.10.7. No-volts Auto Reclose Protection

If the generating facility cannot withstand the acceleration that will occur following a reclose, it is required that the generating facility be equipped with a no-volts relay that trips the facility off during the reclose dead time.

7.3.10.8. Reverse Power Protection

All generators shall have protection designed to trip the unit in the event of power flowing from the grid System into the Generator under any condition except when start-up supplies or for auxiliary supplies when the Generator is not on line.

7.3.10.9. Fault Ride Through Capability

The ability of a generator to ride through selected network faults may be a requirement for network connection depending on the location and capacity of the generator unit. The DNSP shall define the specific faults for each RPP that require fault ride through capability depending on the capacity of the generating units

The DNSP shall define the specific faults for each RPP that require fault ride through capacity depending on the capacity of the generating units.

7.3.10.10. Fault Levels

RPPs generally increase the system fault levels. Before a generating plant is added to the network, it shall be assessed whether existing equipment will be able to sustain the increased fault levels. If the network fault levels are such that mitigating actions are required, then the RPP may be required to meet the additional costs of such mitigating actions.

Where mitigating actions have been put in place to reduce fault levels, the SO shall document maximum fault levels, before and after such actions.

7.3.10.11. Grounding Requirements

The network operator shall inform the RPP of the grounding method used in the grid system. The specification of Equipment shall consider the maximum Voltage Surge that will be imposed on the Equipment during faults involving ground.

7.3.10.12. Protection Coordination at the Point Of Connection

The DNSP shall be responsible for co-ordination of protection at the POC and shall investigate any mal-function of protection or other unsatisfactory protection issues at the POC.

7.3.10.13. Testing of Protection Equipment

The DNSP shall conduct periodic testing of equipment and systems to ensure these are performing to the designed specifications. Periodic tests must be performed within a period of two years.

7.3.11 Metering Requirements

7.3.11.1. The network operator shall provide, install and maintain a four-quadrant meter at the interface with RPP for billing and settlement purposes for each renewable generator connected to its system

7.3.11.2. The metering shall be located on the secondary side of the interconnecting transformer and compensated for losses to the point-of-delivery.

7.3.11.3. The meter shall have a Dual register; revenue approved meter capable of recording real and reactive power and energy delivery to and from the generating facility separately.

7.3.11.4. The generating facility owner shall provide any communication and interface facilities that the network operator and System Operator may require to the metering unit.

7.3.11.5. The System Operator shall provide the RPP with all relevant information on metering requirements.

7.3.11.6. All meters shall be installed and maintained in accordance to the Distribution Grid Code.

7.3.12 RPP performance data

The metering system shall provide operational data in respect of indications and measurements as follows:

a). MW
b). MVAr
c). MWh

d). Voltage
e). Frequency; and,
f). Any other additional data as specified in the connection agreement.

RPPs shall provide the system operator with monthly performance indicators in relation to each unit at each power station in respect of availability and reliability.

RPPs shall report significant events, such as catastrophic failures to the ERB within 24 hours of occurrence of such event.

7.4 Information Requirements

RPPs shall make the following performance indicators available monthly to the ERB:

Table 7-2: Performance Indicators to be submitted to the ERB

Indicator	Performance this month		Performance year to date	
	Actual	**Targeted**	**Actual**	**Targeted**
Energy sold				
Total number of faults				
Number of faults by cause				
% interruptions restored within 2 hours				
% interruptions restored within 24 hours				
Revenue and expenditure data by source and expenditure item				
Total number of accidents recorded				
Number of disabling injuries				
Number of fatalities				
Number of incidents involving property damage				
Accident frequency rate				
Accident severity rate				
Quality of supply				
Over-Voltage events				
Under-voltages events				
Voltage unbalances				
Voltage harmonics and inter-harmonics				
Voltage flicker				
Voltage dips				
Voltage swells				
Voltage transients and surges				
Unplanned interruptions				

8. GOVERNANCE CHAPTER

8.1. Introduction

Whilst each Chapter in the Distribution Grid Code contains the rules and provisions relating specifically to that Chapter, there are provisions which are of more general application. These are covered in this Chapter, the Governance Chapter.

8.2. Objective

The Distribution Grid Code Governance Chapter contains provisions that are of general application to all provisions of the Distribution Grid Code. Their objective is to ensure, to the extent possible, that the various sections of the Distribution Grid Code apply consistently to all users of the distribution system.

8.3. Scope

The Distribution Governance Chapter shall apply to all Users.

8.4. Assistance in Implementation

8.4.1. The Distribution Licence imposes a duty upon the Distribution Network Service Providers (DNSP) to implement and enforce the Distribution Grid Code. In order to do this the DNSP may need access across boundaries, services, and facilities from Users or to issue instructions to Users, for example to isolate or disconnect Plant or Apparatus. It is considered that these cases will be exceptional and it is not, therefore, possible to envisage precisely or comprehensively what the DNSP might reasonably require in order carrying out its duty to implement and enforce the Distribution Grid Code.

8.4.2. All Users are required to abide by the Distribution Grid Code and also to provide the DNSP with such rights of access, services and facilities and to comply with such instructions as it may reasonably require implementing and enforcing the Distribution Grid Code.

8.5. Unforeseen Circumstances

8.5.1. If circumstances arise which the provisions of the Distribution Grid Code have not foreseen, the DNSP shall to the extent reasonably practicable in the circumstances, consult promptly and in good faith with affected Users in an effort to reach agreement as to what should be done. If agreement cannot be reached in the time available the DNSP will determine what is to be done.

8.5.2. Whenever the DNSP makes a determination, it shall have regard, wherever possible to the views expressed by Users, and in any event, to what is reasonable in all the circumstances.

8.5.3. Each User shall comply with all instructions given to it by the DNSP following such a determination provided that the instructions are consistent with the then current technical parameters of the particular User's System registered under the Distribution Grid Code. The DNSP shall promptly refer all such unforeseen circumstances and any such determination to the Distribution Grid Code Review Panel in accordance with 8.7.2 below.

8.6. Hierarchy

In the event of any conflict between the provisions of the Distribution Grid Code and any contract, agreement or arrangement between the DNSP and a User, the provisions of the Distribution Grid Code shall prevail unless the Distribution Grid Code expressly provides otherwise.

8.7. Distribution Grid Code Review Panel (DGCRP)

8.7.1. The ERB shall establish and maintain a Distribution Grid Code Review Panel which, shall be a committee, to carry out the functions referred to in 8.7.2

8.7.2. The Panel shall:

a). Keep the Distribution Grid Code and its working under review.
b). Review all suggestions for amendments to the Distribution Grid Code which participants may submit to the DNSP for consideration by the Panel from time to time.
c). Recommend to the DNSP amendments to the Distribution Grid Code that the Panel feels are necessary or desirable and the reasons for the recommendation.
d). Issue guidance in relation to the Distribution Grid Code and its implementation, performance and interpretation when asked to do so by any User
e). Consider what changes are necessary to the Distribution Grid Code arising out of any unforeseen circumstances referred to it by the DNSP under 8.5.

8.7.3. The Panel shall consist of:

a). Two persons appointed by, and representing the DNSPs
b). One person appointed by and representing the ERB,
c). One person representing the Transmission System Operator,
d). One person representing Embedded Generators;,
e). One person representing Major Customers,
f). One person representing the Rural Electrification Authority
g). One representative of the Engineering Institution of Zambia
h). One representative of independent Suppliers.
i). Two persons representing the transmission network service providers
j). One person representing the ministry responsible for energy

One of the DNSPs will serve as secretariat of the DGCRP.

8.7.4. The Panel shall establish and comply at all times with its own rules and procedures relating to the conduct of the business, such rules and procedures to be known as the Constitution and Rules of the Panel, which shall be approved by the ERB.

8.7.5. The DNSP shall submit all proposed amendments to the Distribution Grid Code (regardless of which party proposes such amendments) to the Panel for discussion.

8.7.6. The DGCRP shall, from time to time or at the behest of the ERB, having regard to the recommendations of the Panel, submit a revised Distribution Grid Code to the ERB for approval.

8.8. Communications between the DNSP and Users

Unless otherwise specified in the Distribution Grid Code, the methods of operational communication and data transfer shall be agreed between the DNSP and Users from time to time.

8.9. Suspension of the Distribution Grid Code

Users should note that the provisions of the Distribution Grid Code may be suspended, in whole or in part, pursuant to any directions given and / or orders made by the Minister under the provisions of the Act.

8.10. Code Responsibilities

The Distribution Grid Code sets out the procedures and principles governing the relationship between the DNSP and all Users of the Distribution System.

8.11. Exemptions

8.11.1 If a User finds that it is, or will be unable to comply with any provision of the Distribution Grid Code, then it shall without delay report such non-compliance to the DNSP and shall, subject to the provisions of 8.11.2 make such reasonable efforts as are required to remedy such non- compliance as soon as reasonably practicable.

8.11.2 Where the non-compliance is:

a). with reference to Plant and/or Apparatus connected to the Distribution System and is caused solely or mainly as a result of a revision to the Distribution Grid Code; or

b). with reference to Plant and/or Apparatus which is connected, approved to connect, or for which approval to connect to the Distribution System is being sought;

and the User believes either that it would be unreasonable (including cost and technical considerations) to require it to remedy such non-compliance or that it should be granted an extended period to remedy such non-compliance it shall promptly submit to the ERB a request for an exemption from such provision in accordance with the requirements of 8.11.3 and shall provide the DNSP with a copy of such application.

8.11.3 A request for exemption from any provision of the Distribution Grid Code shall contain:

a). the issue number and the date of the Distribution Grid Code provision against which the non-compliance or predicted non-compliance was identified;
b). identification of the Plant and/or Apparatus in respect of which an exemption is sought and, if relevant, the nature and extent to which the non-compliance exists;
c). identification of the provision with which the User is, or will be, unable to comply;
d). the reason for the non-compliance; and
e). The date by which compliance will be achieved (if remedy of the non-compliance is possible) subject to 8.11.2 (b).

A standard Distribution Grid Code Exemption Application form is included in Appendix C.

8.11.4 If the DNSP finds that it is, or will be, unable to comply with any provision of the Distribution Grid Code, then it shall, subject to the remaining provisions of 8.11 make such reasonable efforts as are required to remedy such non-compliance as soon as reasonably practicable.

8.11.5 In the case where the DNSP requests Exemption, the DNSP shall submit the information set out in 8.11.3 to the ERB.

8.11.6 On receipt of any request for exemption, the ERB shall promptly consider such request and provided that the ERB considers that the grounds for the Exemption are reasonable, the ERB shall grant such Exemption unless the Exemption would, or it is likely that it would have a material adverse impact on the security and stability of the Distribution System or imposes unreasonable costs on the operation of the Distribution System or Transmission System or on other Users. In its consideration of an Exemption request by a User, the ERB may contact the relevant User and or the DNSP to obtain clarification of the request to discuss changes to request. Where the Exemption may have an impact on the Transmission System, the DNSP shall liaise with the TSO prior to providing an assessment to the ERB.

Exemption from any provision of the Distribution Grid Code shall contain:

a). The issue number and the date of the Distribution Grid Code provision against which the exemption applies;
b). Identification of the provision with which the exemption applies;
c). Identification of the Plant and/or Apparatus in respect of which an exemption applies and, if relevant, the nature and extent to which the exemption applies including alternate compliance provision;
d). The reason for the non-compliance requiring exemption;
e). The date by which the exemption ends if compliance will be achieved, or by which such exemption expires.

8.11.7 To the extent of any exemption granted in accordance with this 8.11, the DNSP and/or the User (as the case may be) shall be relieved from its obligation to comply with the applicable provision of the Distribution Grid Code and shall not be liable for failure to so comply but shall comply with any alternate provision as set forth in the exemption request.

8.11.8 The DNSP shall:

a). Keep a register of all exemptions which have been granted, identifying the name of the person in respect of whom the Exemption has been granted, the relevant provision of the Distribution Grid Code and the period of the Exemption; and
b). On request from any User, provide a copy of such register of exemptions to such User.

8.11.9 Where a material change in circumstance has occurred, a review of any existing exemptions, and any exemption requests under consideration, may be initiated by the ERB at the request of the DNSP, or Users.

APPENDIX A EMBEDDED GENERATOR APPLICATION FORM

Note: This form to be completed in full and returned to the DNSP together with requested information for review and approval/disapproval

SN.	ITEM
1.	**Date of Application:**
2.	**Applicant Particulars:** Name of Applicant: Address: Telephone: Fascimile: Email:
3.	**Project Details:** Project Name: Project Location: Project Contact Name & Telephone Number: Fascimile: Project Type: (co-generation, combined cycle, hydraulic etc.)
4.	**Construction Schedule:** Projected Start-up of Construction: Construction Power Requirements: Projected In-Service Date of Embedded Generator:
5.	**Site plan:** Site plan to show scaled mapping of existing lot lines, road crossing etc
6.	**Preliminary design:** Design to show generators, transformer, proposed point of connection, isolating devices, protection schemes etc.
7.	**Generator specifications** Manufacturer: Fuel type: Rated MVA: Rated MW: Rated Voltage: Rated Power Factor: Inertial Constant: Maximum MVAR Limit: Neutral to Earth Resistance in Ohms: Xd – Synchronous reactance in p.u:

	X’d - Direct Axis transient reactance in p.u: X”d – Direct axis sub-transient reactance in p.u: X2 – Negative sequence reactance in p.u: X0 – Zero sequence reactance in p.u
8.	**Generator and unit transformer specifications** Voltage and power ratings: Windings configuration: Neutral earth resistors or reactors: Positive and zero sequence impedances in p.u: R1: X1: RO: XO:
9.	**Expected Consumption (details to be clarified with the relevant DNSP):**
10.	**Future Site Developments plans:**
11.	**Proposed Plant Design:** Operating characteristics:
12.	**Any other additional information:**

I request the DNSP to proceed with a preliminary review of this Embedded Generation interconnection application and I agree to pay the cost associated with completing this review.

I further consent to the DNSP providing this information to the TNSP and other DNSPs as required.

Name: ______________________________ Signature: ______________________________

Title: ______________________________ Date: ______________________________

APPENDIX B STANDARD NET METERING APPLICATION FORM

Note: This form is to be completed in full and returned to the DNSP together with requested information for review and approval/ disapproval

SN	Item
1.	Date:
2.	Applicant Particulars
	Name of Applicant:
	Postal and Street Address (Include suburb in street address. Street address must be where the embedded generator will be erected):
	Telephone:
	Cellular phone:
	Fax:
	Email:
	Distribution licensee Account Number:
3.	**Installer Particulars**
	Name:
	Postal Address:
	Telephone:
	Cellular phone:
	Fax:
	Email:
	Registration No with Distribution licensee
4.	**Generation Particulars**
	Manufacturer:
	Fuel Type (Solar, Wind, Hydro, Renewable biomass, Biogas, Other [specify]):
	Generator Type (Synchronous, Induction, Inverter, Other [Specify]):
	Power Factor (pu):
	Ratings (kW and kVA):
	Voltage (V):
	Frequency (Hz):
	Projected Annual Electricity Generation (kWh):
5.	**Installation Details**
	Attach a SITE PLAN to show scaled mapping of boundaries; locations of power station, meter and point of connection to distribution network; etc.
	Attach a SINGLE LINE DIAGRAM to show preliminary design including generator, meter, point of connection, isolating devices, protection schemes, etc
	Safety and Anti-islanding measures (describe):
	NOTE: For standardisation the Distribution licensee will install the net meter, should a new meter be required. In accordance with the connection charge policy, the cost of a new meter, should it be required, must be paid by the net metering applicant, subject to this application be approved.

6.	**Construction Schedule**
	Projected Start-up of Construction:
	Projected In-Service Date of Embedded Generator:
7.	**Any other additional information:**

I request the DNSP to proceed with the evaluation of this embedded generation interconnection application and await your formal approval or disapproval with reasons within fifteen (15) working days from receipt of this application.

I further consent to the DNSP providing this information to the ERB as required.

Name: ____________________ Signature: ____________________

Title: ____________________ Date: ____________________

APPENDIX C EXEMPTION REQUEST FORM

<table>
<tr><th colspan="4">DISTRIBUTION GRID CODE EXEMPTION REQUEST FORM</th></tr>
<tr><td>DGC E No.:</td><td colspan="3"></td></tr>
<tr><td colspan="4">Clause For Which Exemption Is Sought:</td></tr>
<tr><td>Section(s):</td><td></td><td>Page(s):</td><td></td></tr>
<tr><td colspan="2">Plant/ Apparatus for which exemption sought:</td><td colspan="2"></td></tr>
<tr><td colspan="2">Extent of Non-compliance:</td><td colspan="2"></td></tr>
<tr><td colspan="2">Reason for Exemption:</td><td colspan="2"></td></tr>
<tr><td colspan="4">Duration for which exemption is sought:</td></tr>
<tr><td>From:</td><td></td><td>To:</td><td></td></tr>
<tr><td colspan="2">Proposal for remedying non-compliance (milestones for remedying non-compliance, costs, risk factors):</td><td colspan="2"></td></tr>
<tr><td colspan="2">Details of supporting documentation for application (if any) attached:</td><td colspan="2"></td></tr>
<tr><td colspan="2">Exemption Application Submitted By:</td><td colspan="2">Date of Submitting Application:</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="4">Completed form to be returned to the DGC Review Panel Secretary</td></tr>
</table>