POWER QUALITY MANAGEMENT FRAMEWORK FOR THE ELECTRICITY SUPPLY INDUSTRY IN ZAMBIA

JUNE 2014

CONTENTS

EXECUTIVE SUMMARY

Following the development and consequent review of Power Quality (PQ) and Reliability standards and establishment of the power quality benchmark on the Zambian power system through a Power Quality study, the ERB has developed a Power Quality Management System which focuses on a long term mechanism to continuously monitor the power quality performance of the Zambian grid and its improvement over time. The Zambia Power Quality Management System (PQMS) makes available a framework for implementation of the Power Quality Directive.

The PQMS provides rights and responsibilities of all stakeholders (the licensees, customers and equipment suppliers) in the Electricity Supply Industry (ESI) and aims at providing:

i). A mechanism to ensure that customers are correctly informed of their rights and obligations with regard to the power quality supplied by their utilities;

ii). Ensure that the appropriate power quality performance information is made available through measurement, data management, and statistical analysis;

iii). Accessible complaints resolution mechanisms, to ensure that workable procedures are in place to resolve customer power quality concerns;

iv). Ensure the long-term sustainability of the supply industry with regard to power quality; and

v). Ensuring that the interests of licensees and their customers are balanced in as far as power quality and reliability of supply is concerned.

In order to enforce the technical requirements for the quality and reliability of electricity supplied by the electricity supply industry, a Power Quality Directive (PQD) has been generated for implementation by all the Licensees. The PQ directive orders the licensees to put in place a power quality management system that will ensure that power quality parameters at the points of common coupling among the respective stakeholders are monitored, measured, recorded and analysed for future system improvement and potential complaints resolution with customers. The main objective of this PQ Directive is to compel all licensees to present and establish a uniform methodology and guidelines to measure Power Quality and reliability (PQR) parameters in the Zambia ESI.

The following directives are hereby issued for all licensees in the electricity Supply industry:

DIRECTIVE 1: It is hereby ordered that all Licensees install Power Quality Recorders at sufficient locations in their electrical networks to

adequately characterize and report performance system as prescribed in ZS 387.

DIRECTIVE 2: It is directed that all licensees compile and submit reports to the ERB relating to power quality and reliability of supply on a quarterly and annual basis. Any Licensee who has valid reasons for not being able to report as required shall advise the ERB of their circumstances in writing as soon as they become aware of their inability to comply.

The ERB may, at its discretion, exempt Licensees from some reporting requirements on the basis of a properly motivated written application being received in good time before reports are due.

DIRECTIVE 3: It is hereby directed that all the Licensees maintain records necessary to produce annual statistics as per ZS 387 standard reporting format and shall report annually to the ERB, including an analysis of the performance during the year under review.

It is further expected that Licensees shall on request make available fault statistics for any given site to the ERB or potential or existing customers.

DIRECTIVE 4: It is directed that all Licensees shall manage the fault performance of their respective networks. A formal annual review process is expected to be established by the licensees who shall review the fault performance for the year and identify areas of concern and appropriate corrective action. The results of this review process shall be reported to the ERB as prescribed in ZS 387.

DIRECTIVE 5: It is directed that all licensees shall use Power quality monitoring instruments that is compliant to ZS 387 (as a minimum). The licensee shall ensure that these instruments are equipped with flexible communication options that allow easy remote access.

DIRECTIVE 6: It is directed that all Licensees responsible for generation, transmission, distribution and supply of electricity have to co-ordinate their contractual relationships with one another, with respect to power quality and reliability of supply based on the requirements of ZS 387.

DIRECTIVE 7: It is directed that the Licensees monitor the power quality and reliability at the point of common coupling and the Licensee and the Consumer shall collaborate in drawing up appropriate operational procedures to facilitate the monitoring and reporting of power quality and reliability of supply. It is further expected that the minimum PQR standard stipulations are maintained at the point of supply to consumers.

DIRECTIVE 8: It is further directed that where complaints arise, it is expected that the consumer and the licensee will make efforts to resolve the complaint before referring the matter to the ERB. Where a complaint concerning poor PQR is referred to the ERB, the procedure outlined in section 4.5 of ZS 387 part 2 shall apply.

DIRECTIVE 9: It is directed that licensees shall ensure all contracts with the new grid customers or revised contracts shall include the appropriate power quality and reliability provisions as stipulated in this PQD.

1. INTRODUCTION

1.1 Overview

Power quality management is an important aspect of managing risk in the electrical supply industry (ESI). The effectiveness of any power quality management program is determined by the degree to which the licensee and their customers approach power quality issues. The assumptions on which utilities base their power quality management programs will have a significant effect on the costs involved and the performance levels attained.

Through this paper the ERB aims at defining a framework for power quality management in Zambian ESI, specifying the role of the ERB in regulating Power Quality in the ESI, and the requirements such as the responsibilities and obligations of the licensees. It also specifies the requirements, rights and responsibilities of the customers and further highlights the specific future actions required to support this framework. By defining this framework, the assumptions on which power quality management programs are defined shall be transparent to all stakeholders.

1.2 Aims of Power Quality Management System

The aims of the Power Quality Management System are as follows:

i). To put in place mechanisms that will ensure that customers are correctly informed of their rights and obligations with regard to the power quality supplied by their utilities.
ii). Establish accessible complaints resolution mechanisms, and ensure that workable procedures are in place to resolve customer power quality concerns.
iii). Establish the broader technical and legal framework for resolving disputes.
iv). Identify appropriate standards and codes of practice on power quality that need to be developed or reviewed.
v). Ensure the long-term sustainability of the supply industry with regard to power quality.
vi). Ensure that the appropriate power quality performance information is made available through measurement, data management, and statistical analysis.
vii). Ensuring that the interests of licensees and their customers are balanced

2. POWER QUALITY MANAGEMENT SYSTEM – REGULATORY FRAMEWORK

2.1 PQMS Requirements

The licensee shall put in place a PQMS which will be based on the components provided for in this framework as follows:

i). Standards, technical guidelines, codes of practices and PQ directive

These will be the basis on which the ERB will review licensee performance when receiving customer complaints.

ii). A defined procedure for interaction between a licensee and its customers:

A minimum requirement for interaction between the licensee and the customer on power quality issues is that the following is communicated:

- Network type / design philosophy: A basic description of the type of network the customer will be connected to and the types of problems that the network may experience.
- Indicative levels of quality to be received: These are based on the specific network or network type and performance data
- Customer responsibilities with regard to emission (pollution) levels: In the case of large customers, these are specified in ZS 387 and in the case of small customers they are generic.
- Customer responsibilities with regard to immunity: Based on the type of customer and the network quality levels, consideration should be given by customers to what countermeasures need to be implemented.
- The complaints procedure: The way that complaints on power quality are dealt with, and who to contact with such complaints (including how these are escalated to the ERB). The detail and specific nature of the above information will depend on the type of customer category. For large customers, measured historical performance is appropriate. For small customers, indicative and characteristic values for the type of network and supply area are appropriate.

2.2 Transmission Licensee's Responsibilities

Transmission licensee is an entity that is licensed to own and maintain transmission equipment.

2.2.1 Responsibility for Quality of Supply Performance

The Transmission Licensees shall be responsible for the quality of supply delivered to all its customers at every point of supply.

The Transmission Licensees shall further be responsible for managing the voltage pollution contributed by any Transmission customer at the point of common coupling. The preferred method of managing this aspect will be through power supply contracts containing quality of supply provisions. Where such contracts do not exist and/or cannot be immediately amended, the Transmission Licensees shall negotiate solutions to quality of supply and voltage pollution issues with the customers in question.

The Transmission Licensee shall also be responsible for contracting appropriate quality of supply with Generators and other transmission energy suppliers as may be appropriate in Zambia from time to time.

2.2.2 Implementation of Quality of Supply Contracting

The Transmission Licensees shall include appropriate quality of supply provisions in all new power supply contracts. Such provisions shall deal with all quality of supply parameters dealt with in ZS 387.

The Transmission Licensees shall also amend any existing power supply contracts at the soonest future opportunity where such contracts can be amended to include appropriate quality of supply provisions, unless such contracts already contain such provisions.

Such contracts shall provide for:

- Allowable voltage pollution level contribution by the customer, based on the Transmission Licensee's calculations in accordance ZS 387; and
- Typical interruption and dip performance (as defined in ZS 387) of the network at the point of common coupling, should such information be available;

Where the Transmission licensee fails to meet the standard parameters, it shall take reasonable steps at own costs to overcome the shortcomings. In terms of this framework, it is a requirement that all new grid customers and all new or revised contracts shall include the appropriate power quality clauses.

2.2.3 Implementation of Quality of Supply Measurements

2.2.3.1 Agreed Recorder Placements

The Transmission Licensees shall install and maintain QOS recorders as stipulated by ZS 387 at points of supply or points of connection.

2.2.3.2 QOS Databases

The Transmission Licensees will maintain a QOS database which will receive measurement data from all QOS meters installed by the Transmission Licensee. The QOS data recorded by the meters and stored in the database shall comply with the specifications of the Quality of Supply Standard ZS 387.

2.2.3.3 Data Management

The Transmission Licensees will ensure that its QOS data is properly and professionally managed to ensure consistency and data security.

2.3 Distribution Licencees' Responsibilities

Distribution Licensees are entities holding an electricity distribution license issued by the ERB.

2.3.1 Responsibility for Quality of Supply Performance

The Distribution Licensee shall be responsible for the quality of supply delivered to all its customers at all respective points of common coupling.

The Distribution Licensee shall further be responsible for managing the voltage pollution contributed by any Distribution customer at the point of common coupling. The preferred method of managing this aspect will be through power supply contracts containing quality of supply provisions. Where such contracts do not exist and/or cannot be immediately amended, the Distribution Licensee shall negotiate solutions to quality of supply and voltage pollution issues with the customers in question.

The Distribution Licensee shall also be responsible for managing the voltage pollution contributed to the transmission system at any point of common coupling. This should be done through an appropriate quality of supply contract with the Transmission Licensee and will be guided by the Grid Code requirements.

In the case of domestic and other small customers it will not be practical to contract individually for quality of supply. The Licensee should publish general quality of supply information applicable to small customers and make such publication(s) available to the affected customers in order to educate them regarding quality of supply and the responsibilities of the Licensee and the customer.

2.3.2 Implementation of Quality of Supply Measurements

The implementation of quality of supply (voltage quality and continuity) requires the utility installation of Power Quality Recorders by the utility at strategic places as guided by ZS 387.

2.3.2.1 Agreed Power Quality recorder Placements

The Power Quality recorders will be purchased, installed and managed by Distribution Licensees and placed according to site class defined by the ZS 387 (as a minimum requirement).

2.4 Supply Licensees' Responsibilities

Supply Licensees are entities who hold a valid electricity supply license issued by the ERB. The supply license essentially covers the "retail" operation and as such is primarily concerned with service quality.

2.4.1 Responsibility for Quality of Supply Performance

The power supply agreements concluded between distribution and transmission licensees and end customers are made under the respective supply licenses. However the supply contracts deal with both the "wires" business and the "retail" business. The provisions relating to quality of supply under the "wires" has been dealt with under the transmission and distribution licensee responsibility sections respectively.

This section deals with the service quality delivered to customers under the supply licenses. The Supply Licensee is responsible for service quality (also referred to as commercial quality) to the customer. This refers to the quality of interactions with customers (where customers include potential customers) as defined in the Electricity Supply - Quality of Consumer Service Standard (ZS 397), and includes:

i). Personal interaction at service centres or elsewhere
ii). Telephonic interaction
iii). Written interaction, including quoting, billing and dealing with queries and complaints

It is expected that the end customer will contract with the Supply Licensee and shall include provisions for quality of supply. Such provision for quality of supply shall reflect the conditions for quality of supply contained in the contract between the Distribution/Transmission Licensee and the Supply Licensee.

2.5 Customer Rights and Responsibilities

As the impacts of power quality problems are a function of both utility performance and customer sensitivity and emissions, customers have certain basic rights and responsibilities with regard to power quality. These rights and responsibilities that are provided in this section and should be considered as a starting point in the licensee / customer relationship.

2.5.1 Customer Rights

Customers shall receive power at a level of voltage quality that is no worse than that provided in ZS 387. Should this not be the case, the licensee is obliged to take corrective action where such problems are identified.

Customers have the right to complain according to the process defined under section 2.7 Customers have the right to be clearly informed about the complaints process, including the manner by which complaints are escalated to the ERB.

Large customers have the right to the allocation of specific emission levels and to be treated fairly when utilities calculate these emission levels. The techniques for undertaking these calculations are outlined in the ZS 387 standard. Customers have the right to further negotiate these levels, based on the provisions in the standards. Should a compromise not be reached between the customer and the licensee, the customer can have recourse to the ERB.

New and existing customers have the right to information on the power quality performance at the site at which the plant is to be located, where such information is available.

2.5.2 Customer Responsibilities

Customers shall operate their equipment so as not to affect other users. ZS 387 shall be used as the standard for assessing the impact (pollution) that a piece of equipment may have on the network.

Voltage transients due to lightning or switching cannot be prevented by a licensee. It is the customer's responsibility to ensure that suitable surge protection is in place.

For large customers, where specific emission ("pollution") levels are not specified in the contract with the supplier, customers shall design and operate their equipment so as not to affect other users. In general, however, the levels of emission ("pollution") allowed will be calculated by utilities using one of the techniques listed in the standards. Customers should take all power quality parameters (including voltage dip and interruption performance) into consideration when designing new installations. This implies equipment tender specifications that call for power quality performance information. Where possible, records should be kept of design choices, as these may provide potential support for future complaints to the ERB.

2.6 Measurements and Reporting Procedures

2.6.1 General

The ERB will expect licensees to compile and submit reports relating to quality of supply and service. Any Licensee who has valid reasons for not being able to report

as required shall advise the ERB of their circumstances in writing as soon as they become aware of their inability to comply.

The ERB may, at its discretion, exempt Licensees from some reporting requirements on the basis of a properly motivated written application being received in good time before reports are due.

2.6.2 Quality of Supply Reporting

This framework requires all Licencees to submit quarterly and annual PQ reports in compliance with ZS 387.

2.6.3 Data Access

The ERB shall have the right to request Licensees to provide the ERB with extract copies of Power Quality data as collected by the Licensee.

A customer shall have the right to access Power Quality Data related to their account(s) and supply data from meters at or close to their point(s) of common coupling.

2.6.4 Reporting Formats

The required reporting formats will be provided by the ERB to the Licensees. Sample formats are provided in the annexures of ZS 387.

2.6.5 Publication of Annual Power Quality Statistics

The summary of Power Quality statistical reports shall be published annually by the ERB and progress in terms of the plan laid out in the guidelines, including comparative power quality performance statistics for the various utilities shall also be published.

2.7 Complaints and Dispute handling

For transmission licensees and their customers, the complaints and dispute handling procedure is outlined in the Grid code. For distribution licensees and their customers, the following procedure shall apply:

2.7.1 Complaints Handling Procedure

It is important that all stakeholders in the ESI understand and adhere to a common agreed procedure for dealing with complaints regarding Quality of Supply. The framework shall require the ERB to do the following when handling complaints:

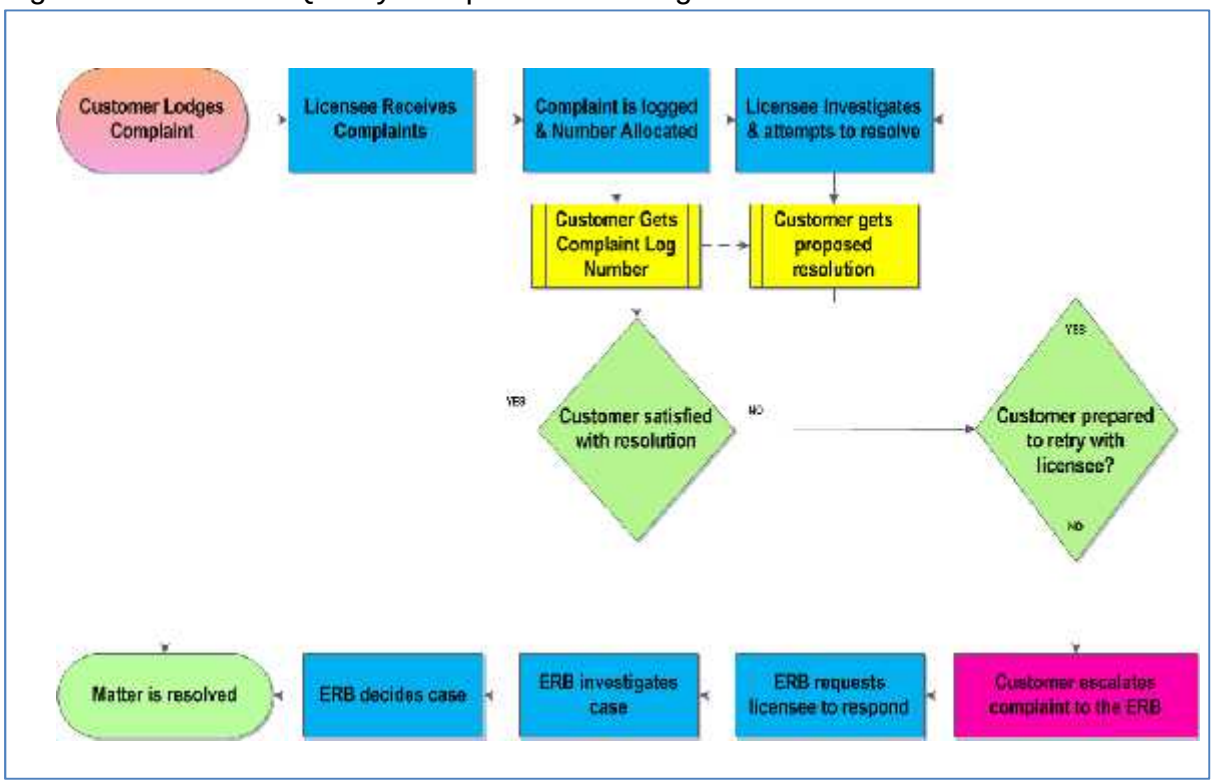
i). Define a clear process for escalating complaints of licensee power quality performance to the Regulator

ii). Define a clear process for handling and tracking the progress and post-resolution of complaints

iii). Define a clear set of principles on which each complaint is considered

This section introduces a standard complaints handling procedure which maps out responsibilities and processes to be followed by the various stakeholders.

Figure 1: Power Quality Complaints Handling Procedure Overview



2.7.1.1 Initial Complaint

In case of a complaint the customer should first address the complaint to the Licensee. Complaints should preferably be lodged in writing, but the Licensee should also be prepared to accept verbal complaints.

Upon receipt of a complaint the Licensee shall log the complaint and allocate a unique complaint number which is to be provided to the customer for reference. The Licensee shall keep all documentation associated with the complaint filed under this reference number for easy later retrieval. The Licensee shall retain records of complaints for a period of at least two years.

The Licensee shall advise the customer regarding the time required for the Licensee to respond formally to the complaint.

The Licensee will then proceed to investigate the complaint as speedily as possible. The results of the Licensee's investigation and the proposed remedy (if any) should be submitted to the customer in writing, however in case of minor complaints

telephonic feedback is also acceptable, provided that the date of the feedback is logged by the Licensee.

If the customer is satisfied and accepts the Licensee's conclusions and/or proposed remedy, the Licensee will implement the remedy which will resolve the complaint.

Should the Customer not be satisfied, the customer may either revert to the Licensee and request another attempt to resolve the matter, or otherwise address the complaint to the ERB in writing.

2.7.1.2 Escalation of Complaints to the ERB

After failure of at least one attempt to resolve a complaint directly with the Licensee a customer may escalate the complaint to the ERB for resolution.

The customer shall submit the complaint to the ERB in writing, stating the name of the Licensee, the complaint sequence number issued by the Licensee and as much detail and supporting documentation as is necessary for the ERB to gain a proper understanding of the customer's point of view regarding the complaint.

2.8 Enforcement or incentive mechanism for PQ improvement

The ERB shall set up an enforcement or incentive mechanism for PQ improvement through the regulatory instruments in place. Where certain areas have not been clearly addressed the ERB will review parts of the guidelines to incorporate the areas of need to enhance the enforcement mechanism.

Incentive mechanism shall be developed in the long term and part of the awards shall be determined by complaints dealt with and performance of the licensee. This shall form part of the KPI framework and the manner in which these are addressed will be used as a measure of the performance of the licensee.

3. THE ROLE OF THE ERB IN PQ MANAGEMENT IN ZAMBIA

Having defined what the regulatory objectives and framework, the ERB will be required to undertake the following:

i). Standards Development
ii). Monitor Power Quality Performance Reporting by Utilities
iii). Conduct PQ Audits and Analysis
iv). Costing Power Quality Improvements
v). Handle Complaints and disputes
vi). Provide Communication procedures and be actively involved in awareness programs.

3.1 Standards development

In general, the ERB will regulate the supply industry by reference to agreed national standards, where such standards exist. Where these do not exist, the ERB will initiate the development of these with the appropriate standards body. In some cases the development of a national standard is not appropriate. In these cases the ERB will develop its own requirements through the consultation process described in this directive.

The ERB will, together with Zambia Bureau of Standards (ZABS), initiate and champion the development and maintenance of the standards identified by this directive. Where processes are not in place to develop these standards, the ERB will initiate the establishment of these with the relevant standards body.

The ERB will ensure that relevant stakeholder involvement is maintained, and that public access is available in the development process (see communication activity below). The ERB will facilitate the establishment of mechanisms for ensuring that relevant stakeholder input to these standards is captured and processed.

The ERB will also from time to time benchmark local regulatory power quality standards against international standards. Where appropriate, review locally developed standards.

3.2 Power Quality Performance Monitoring

The ERB will require a minimum level of annual performance reporting for the purposes of benchmarking and analysing trends in the industry.

The ERB will:

i). Define power quality performance reporting requirements
ii). Where appropriate, publish comparative and trended information (where comparative figures are published, explanatory notes will be included)
iii). Provide the latest copies of submission formats
iv). Institute a simple help system for dealing with queries on the reporting requirements
v). Track and manage overdue submissions

PQ Performance submissions and published statistics will be on an annual basis.

3.3 Audit and Analysis

The ERB will from time to time commission audits to verify and enhance:

i). The quality management system
ii). The quality of the data/information reported

iii). The appropriateness of the data reporting mechanisms.

These will be detailed in an audit plan, which will specify the level at which auditing will be undertaken (i.e. an audit of utility's audit systems or more detailed audits)

Audits may be triggered by:

i). The content of a published audit plan (e.g. in the case of the quality Management system, standard information, and data reporting)
ii). A specific requirement for an audit (e.g. requirement by customers for an independent review of reports by licensees on major incidents)

The aim of the audit process is to improve the transparency and quality of the information reported by licensees, and to identify shortcomings that will require redress. Redress will be taken by the ERB in accordance with its powers as defined in the Electricity Act in cases where:

i). There is evidence of wilful withholding or tampering with data
ii). Shortcomings identified by the ERB are not addressed appropriately

It is expected that the following areas will form part of the audit plan:

i). An audit of the implementation of quality management systems by licensees in terms of this Directive
ii). An audit of the processing and handling of PQ complaints and claims
iii). An audit of the integrity of the reporting system (e.g. annual dip and interruption performance figures and instrument placement.

Note: an internal audit process is generally a basic requirement of a quality management system.

3.4 Costing Power Quality Improvements

The ERB will initiate and participate in the development of a methodology for costing improvements to the power quality performance of licensee networks (e.g. i.e. separate projects specifically defined by utilities for improving quality).

3.5 Complaints Handling

The ERB will define a clear set of principles and processes for handling complaints as guided under section 2.7:

The ERB will act initially as a mediator, when a complaint has been escalated due to lack of resolution between the customer and the utility. Unless otherwise agreed, the ERB will act as arbitrator, should a mediated resolution not be achieved after meeting with the customer and the licensee.

The grounds for a ruling by the ERB will be based on adherence to pre-defined technical standards / guidelines and a continuously developing database of precedents. These precedents will be formulated on the above principles, and through consultation with stakeholders.

3.6 Communication

In terms of the power quality management framework in this directive, the ERB will:

i). Publish the rights and responsibilities of customers (including the manner and process by which complaints should be referred to the ERB), and identify the roles that the various stakeholders should play in the management of power quality.
ii). Publish the mechanisms by which licensees will report to the ERB (standard spreadsheets / formats)
iii). Publish or reference educational material and useful information on power quality
iv). Publish advice on the application of Zambian power quality standards. Where standards are under development, the ERB will publish status information.
v). Publish the results of public consultation processes (such as the Position Document on Power Quality in Zambia)
vi). Publish annual power quality statistics and progress in terms of the plan laid out in this Directive, including comparative power quality performance statistics for various utilities

To ensure accurate communication, the ERB's web site will be used for communication with licensees and customers (over and above any additional printed or verbal communication).

The ERB will track the implementation of the plan in this directive and, where necessary make adjustments to the directive.

4. REQUIREMENTS FROM LICENSEES

To ensure the implementation of the Power Quality Management System, the following will be required of all licensees:

i). That all licensees install Power Quality Recorders at sufficient locations in their electrical networks to adequately characterize and report performance system as prescribed in ZS 387

ii). That all licensees shall compile and submit reports relating to power quality and reliability of supply on a quarterly and annual basis. Any Licensee who has valid reasons for not being able to report as required shall advise the ERB of their circumstances in writing as soon as they become aware of their

inability to comply.

The ERB may, at its discretion, exempt Licensees from some reporting requirements on the basis of a properly motivated written application being received in good time before reports are due.

iii). That all licensees maintain records necessary to produce annual statistics as per ZS 387 standard reporting format and shall report annually to the ERB, including an analysis of the performance during the year under review.

It is further expected that Licensees shall on request make available fault statistics for any given site to the ERB or potential or existing customers.

iv). That all Licensees shall manage the fault performance of their respective networks. A formal annual review process is expected to be established by the licensees who shall review the fault performance for the year and identify areas of concern and appropriate corrective action. The results of this review process shall be reported to the ERB as prescribed in ZS 387.

v). That all licensees use power quality monitoring instruments which are compliant to ZS 387 (as a minimum). The licensee shall ensure that these instruments are equipped with flexible communication options that allow easy remote access.

vi). That all Licensees responsible for generation, transmission, distribution and Supply of Electricity have to co-ordinate their contractual relationships with one another, with respect to power quality and reliability of supply based on the requirements of ZS 387.

vii). That all licensees monitor the power quality and reliability at the point of common coupling and the Licensee and the Consumer shall collaborate in drawing up appropriate operational procedures to facilitate the monitoring and reporting of power quality and reliability of supply. It is further expected that the minimum PQR standards are maintained at the point of supply to consumers.

viii). That where complaints arise, it is expected that the consumer and the licensee will make efforts to resolve the complaint before referring the matter to the ERB. Where a complaint concerning poor PQR is referred to the ERB, the procedure outlined in section 4.5 of ZS 387 part 2 shall apply.

ix). That licensees shall ensure all contracts with the new grid customers or revised contracts shall include the appropriate power quality clauses.

5. IMPLEMENTATION OF THE POWER QUALITY DIRECTIVE

Licensees/Utilities will be required to define their own power quality management systems according to the requirements of this directive.

6. IMPLEMENTATION SCHEDULE

The following activities will have to be undertaken towards the implementation of the PQ directive.

Table 2 Schedule of Activities

S/n	Activity	Expected Completion Date
1.	PQ Directive issued.	July, 2014
2.	Hold stakeholders meeting on Implementation of the PQ Directive	August, 2014
3.	Submission of Quarterly reports	January, 2015
4.	Publish Annual statistics reports	March, 2015
5.	Consider constituting an industry wide Technical Advisory Committee (TAC) for PQ.	Subject to stakeholder consultation