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Key Principles and Practical Considerations of the Implementation of NRS 048-6 : A Distribution Licensee Perspective

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1. Introduction

The new NRS 048-6 standard (medium voltage network interruption performance measurement and reporting) was compiled by the author on behalf of the industry NRS 048 working group (WG) under the auspices of the Electricity Suppliers Liaison Committee (ESLC). The WG membership included Government (DPE), the distribution industry, National Energy Regulator of South Africa (NERSA), Eskom Holdings (Transmission, Distribution, KSACS, Research and Strategy) and end-customer representatives.

Medium voltage (MV) is defined as the set of nominal voltage levels that lie above low voltage and below high voltage in the range 1 kV ≤ Un < 44 kV [2].

The NRS 048-6 standard provides a future framework for the measurement principles, key performance measure definitions, high level event data quality assurance, data accuracy auditing requirements, and the requirements for distribution network interruption performance reporting in the South African Electricity Distribution Industry (EDI).

The standard also provides the minimum requirements of an interruption performance management system for either the manual or automatic capturing and recording the interruption event data. The high level interruption cause codes are provided as a minimum requirement for associating the supply interruptions with a common industry cause code hierarchy. The relevant requirements for the disaggregation reporting as well as the annual regulatory reporting, benchmarking reporting and incentive based reporting are provided in the standard.

The overarching key principles and practical considerations for the implementation of the NRS 048-6 standard will be discussed in this paper.

It is hoped that the paper will stimulate discussion on the current preparedness, resource constraints and future requirements of the EDI. The information will be applicable to all the municipalities and metropolitans and will be of direct interest and benefit to all the AMEU members.

Additional technical information not covered in the paper, can be found in the current draft of the NRS 048-6 standard. All AMEU members are encouraged to read the standard.

2. International Regulatory Mechanisms

Historically international electricity regulators implemented a rate of return regulation (RORR) mechanism that had its short comings in terms of managing the network interruption performance of a distributor.

The System Average Interruption Frequency Index (SAIFI) and System Average Interruption Duration Index (SAIDI) are typical network interruption performance measures used by international regulators.

The current international trend is for electricity regulators to include network interruption performance targets (SAIFI and SAIDI) with penalty/reward mechanisms, along with the control of revenues of distribution companies, as part of incentive based regulation (IBR). IBR requires an alignment of the capital investment program, effective operating practices and maintenance programs of the distributor licensee, so that these performance targets levels are met. The typical IBR period duration is 3-5 years (depending on the objective).

A potential future IBR environment (similar to the UK regulatory environment) could be a focus on both SAIFI and SAIDI over the incentive period (3-10 years), but with more emphasis on improving SAIDI. The SAIFI could be sustainably improved by 0.5% to 1.0% per annum, with SAIDI sustainably improved

by 15-30% over the incentive period. To improve SAIFI requires a long term approach and capital investment program while improving SAIDI can be done over the short to medium term by optimising the operating and maintenance programs.

It must be noted that IBR does not only relate to technical performance, but is an entire business efficiency and mobilisation step change that cuts across all the departments, value chains, processes, systems, data, financial and human resource aspects of a distributor licensee.

Currently in Eskom there is a proposed Distribution network interruption performance component (with financial penalties and incentives) of the Eskom Multi Year Price Determination (MYPD) for 2006-2009.

An industry standard for the measurement and reporting of network interruption performance measures will be a critical component for any future IBR mechanisms in South Africa. In particular, the anticipated implementation of Incentive Based Regulation (IBR) will require accurate and consistent reporting methods and accurate and complete data collection, to facilitate appropriate target setting.

3. Key Components of Power Quality

Power Quality (PQ) comprises of quality of supply (QOS) and network interruption performance components as shown in Figure 1 below. Power Quality is the measure of the quality of the electricity supplied (voltage waveform received by the customer), how reliable is the supply (frequency of interruptions) and how available is the supply (duration of interruptions).

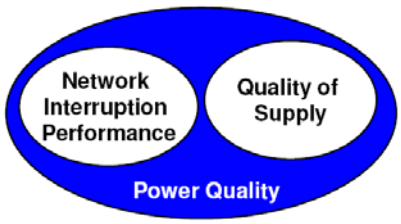

Figure 1 The key components of Power Quality

QOS deals with voltage waveform quality and metrics such as voltage dips (X, Y, Z, T and S class), voltage regulation, harmonics, flicker and unbalance are used. The QOS measurement and reporting requirements is covered by NRS 048-2 [2].

Network interruption performance deals with the reliability (frequency related metrics) and availability (duration related metrics). These can be sustained interruptions (long) or momentary interruptions (short) that are experienced by the individual customers. The measurement and reporting requirements is covered by NRS 048-6.

The key measures of the NRS 048-6 standard are :

- Availability of supply – the average duration of an interruption of supply experienced by the customer.
- Reliability of supply – how frequently on average an interruption of supply is experienced by customer.
- Restoration of supply – the percentage of customers that had their supply restored within a specified target time after an interruption (based on NRS 047 requirements).
- Worst served customers – the percentage of individual customers that receive poor network interruption performance levels.
- MV and HV transformer unavailability – the average duration of interruption of supply that affects the MV/LV and HV/MV transformers only
- Network reliability – the frequency of interruptions occurring on network normalised to 100km.

4. Overview of Related NRS Standards

Table 1 below provides an overview of the current standards in the NRS 048 suite of documents.

High voltage (HV) is defined as the set of nominal voltage levels that are used in power systems for bulk transmission of electricity in the range 44 kV ≤ Un ≤ 220 kV [2].

Table 1 Overview of NRS 048 standards

Standard Title	NRS 048 Part	Current Status
Voltage characteristics, compatibility levels, limits and assessment methods	NRS 048-2	finalised and sent for ELSC voting
Application practices for licensees	NRS 048-4	finalised and sent for ELSC voting
Medium voltage network interruption performance measurement and reporting	NRS 048-6	final draft and WG and ELSC voting pending
Application practices for end customers	NRS 048-7	draft and work in progress
HV and EHV network and large customer interruption performance measurement and reporting	NRS 048-8	proposed future work and pending ELSC approval

The NRS 047-1 standard provides the quality of service required measurement and reporting requirements [1].

5. Compilation of the Standard

In compiling this standard, the NRS 048 WG was guided by key local experiences and international developments such as :

- The IEEE P1366 standard *"Full Use Guide for Electric Power Distribution Reliability Indices"*

- The work and recommendations of the international IEEE Task Force on Reporting Practices
- The recommendations of Cigré Technical Report TB261, *"Power Quality Indices and Objectives"*
- The United Kingdom (UK) regulatory standard of the Office of Gas and Electricity Markets (ofgem), *"Quality of Service Regulatory Instructions and Guidance"*
- The experiences and lessons learnt by Eskom Distribution and the various AMEU members.

The regulatory requirements of the NERSA and the business and operational needs of the distributor licensees were taken into account in the preparation of this part of NRS 048.

In order to measure, assess, and audit the reliability and availability of electricity supplied by the distributor licensees, the NERSA will require the distribution licensees to have uniform and robust measurement and reporting procedures in respect of network interruption performance. This will be important to reduce regulatory uncertainty and provide confidence in the interruption of supply related indices supplied by the distributor licensees of South Africa. In terms of the requirements and principles of economical and affordable electricity supply in South Africa, it is essential to achieve a fair balance between the cost and the adequacy of the measurement and reporting requirements.

6. Scope of the NRS 048-6 Standard

The key aspects addressed in the NRS 048-6 standard are :

a) Interruption performance measurement and data collection requirements
b) Performance indices for reporting and the calculation method of these indices
c) Segmentation according to voltage group (low, medium and high)
d) Segmentation of network and a basis for future segmentation of customer types for reporting purposes
e) Treatment and reporting requirements of major events
f) Handling of exclusions and inclusions of events for the various reporting requirements
g) Data collection of interruption cause codes according to a standard hierarchy
h) Requirements for the disaggregation for annual regulatory, benchmarking and incentive based regulation reporting
i) Data management and archiving and system related changes
j) Estimating the accuracy of reporting through event data audits

The quality of service related measures (such as the number of planned interruptions starting and ending on time and the effective customer communication about pending planned interruptions) are not in the scope of this part of NRS 048 and are covered in NRS 047 (or future possible revisions). This standard only covers the technical performance measures experienced the customers.

The standard provides for a range of indices that can be used for regulatory reporting and internal performance management by the distributor licensees. Some of these indices are customer-based (providing the average frequency and duration of interruptions experienced by the customers), or are load-based indices (providing the frequency and duration of loss of load) and others are network-based (providing the frequency and duration of interruptions on networks).

Performance indices defining worst-served customers are also provided to ensure that the performance levels of individual customers are also monitored (not "lost" in the reported average performance values), reported and improvement or mitigation projects implemented where necessary.

7. Definition of an Interruption of Supply

Supply interruptions refer to the complete (100%) voltage loss on one or more phases for longer than 3 seconds.

An interruption is not defined in terms of voltage measurements, but rather in terms of the disconnection of the supply point. Voltage measuring instruments may in some cases provide erroneous information of whether an interruption occurred or not. Instruments specified in accordance with SANS 61000-4-30 may be used to assist in the interruption assessment.

The interruption can be a sustained interruption or a momentary interruption of supply. A network event of duration 3 seconds or less and with partial or full voltage loss, is classified as a voltage dip (refer to [2]).

7.1 Interruptions on HV networks

Momentary interruptions (HV) : interruptions of supply in the range > 3s to ≤ 1 minute.

Sustained interruptions (HV) : interruptions of supply with a duration > 1 minute.

In general a 1 minute limit differentiates all automatic reclose operations (ARCs) from events involving manual operator intervention. The 1 minute classification aligns with the commonly used international classification of 1 minute for sustained interruption of supply for transmission distributor licensee's.

7.2 Interruptions on MV and LV networks

Momentary interruptions (MV/LV) : interruptions of supply in the range > 3s to ≤ 5 minutes.

Where an interrupting device has a sequence of operations, those momentary interruptions shall be counted as separate momentary interruptions.

Sustained interruptions (MV/LV): interruptions of supply with a duration > 5 minutes

8. Sustained Interruption Indices

The following are the key sustained interruption indices used and their definitions.

SAIFI (System Average Interruption Frequency Index) : The SAIFI of a network indicates how often on average (frequency) the customer connected would experience a sustained interruption per annum. Mathematically SAIFI can be expressed as :

$$\text{SAIFI} = \frac{\text{Total number of customer interruptions p.a}}{\text{Total number of customers served}} \quad (1)$$

SAIDI (System Average Interruption Duration Index) : The SAIDI of a network indicates the average duration of a sustained interruption the customer would experience per annum. It is commonly measured in customer minutes or customer hours of interruption. Mathematically SAIDI can be expressed as :

$$\text{SAIDI} = \frac{\sum \text{customer interruption durations p.a}}{\text{Total number of customers served}} \quad (2)$$

CAIDI (Customer Average Interruption Duration Index) : The CAIDI of a network indicates the average duration of a sustained interruption that only the customers affected would experience per annum. It is commonly measured in customer minutes or customer hours of interruption.

This index differs from SAIDI in that only the total number of customer interruptions is used in the denominator and not all the customers served. Mathematically CAIDI can be expressed as either :

$$\text{CAIDI} = \frac{\sum \text{customer interruption durations p.a}}{\text{Total number of customers interruptions}} \quad (3)$$

Numerically SAIDI = CAIDI x SAIFI. The general case is for CAIDI < SAIDI, as CAIDI only takes into account the number of effected customers.

HSLI (HV Supply Loss Index) : The HSLI of a network indicates the average network loss duration by the HV plant installed due to sustained interruptions caused by only Distribution per month. It is a measure of the HV transformer unavailability and is expressed as minutes per month. The HSLI will also include HV plant that has been affected by MV related through faults on the network. Mathematically HSLI can be expressed as :

$$\text{HSLI} = \frac{\sum \text{MVA.Hours lost per month}}{\text{Installed HV MVA base}} \quad (4)$$

The HSLI is comparable to the Transmission System Minutes (SM) measure, but using the installed transformer rating (name plate rating) instead of the actual load interrupted that is measured.

MSLI (MV Supply Loss Index): The MSLI of a network indicates the average network loss duration by the MV and LV plant installed due to sustained interruptions caused by Distribution only per month. MSLI is mathematically similar to equation 4 above but with the MV transformers and MV related MVA used in the equation. It is a measure of the MV transformer unavailability and is expressed as hours per month.

The above indices can be further broken down into their planned and unplanned components for detailed reporting and analysis.

9. Interruption Categories for Reporting

In order to facilitate the various reporting requirements, categories and associated sub-categories of sustained and momentary interruptions are listed below.

The detailed definitions and application of the interruption categories is provided in NRS 048-6.

9.1 Unplanned interruption (“U”)

a) Network event [“UN”]
b) Emergency [“UE”]
c) Major event [“UM”]

9.2 Planned work (“P”)

a) Pre-arranged [“PA”]
b) Major event [“PM”]

The planned work activity categories are covered in NRS 082. For the purposes of this part of NRS 048, the planned work execution refers to all planned (corrective and preventative) work activities that results in an interruption of supply experienced by the customer.

9.3 Customer related (“C”)

a) Customer caused [“CC”]
b) Customer requested [“CR”]

9.4 Intake supply related (“S”)

a) Unplanned [“SU”]
b) Planned [“SP”]
c) Load shedding [“SL”]

The supply related category also includes the unplanned interruptions caused by or the planned interruptions requested by distributed generation.

The load shedding related interruptions are indicated for completeness. These events shall be carefully recorded, assessed and reported separately, These interruptions must not be included in the normal network interruption performance statistics.

10. Principle of Re-interruptions

The subsequent interruptions due to fault finding or network operating or switching that are associated with the original network interruption shall be referred to as a "re-interruptions". These subsequent interruptions need to be carefully considered, so that they are not unnecessarily included in the network interruption performance index calculations and unfairly penalise the distributor licensee with "double counting" of interruptions. Counting the subsequent interruptions due to fault finding and network switching unfairly penalises the licensee and forces the incorrect behaviour and fault finding and restoration of supply practises from the field staff.

Any re-interruption must occur less than 3 hours after the first interruption and with the cause code of the interruption at the same physical location on the network as the original interruption. The actual interruption duration time will be used (sum of all the interruptions experienced), but the frequency will only be counted as one interruption. Re-interruptions only apply to unplanned related work.

An interruption occurring 3 hours or longer after the previous interruption, will be counted as a new interruption, even if occurring at the same location on the network.

The international average for CAIDI is around 2 hours per annum. Setting a re-interruption time window of 3 hours would therefore be appropriate. The UK regulator (OFGEM) also specifies a re-interruption time of 3 hours for the annual performance reporting.

The above concept of a re-interruption can be illustrated by the following example. A MV network has an loss of supply for 1 hour for all the connected customers, the whole network has supply restored for 30 minutes (assuming no supply step restoration), the whole network has a further loss of supply for 30 minutes, then entire network then has supply permanently restored. The network event would be reported as all the customers experiencing 1 sustained interruption for a total duration of 2 hours.

The distributor licensee is still encouraged (and in future regulatory incentives funding will hopefully be made available) to restore supply to the customers in the shortest possible time through distribution automation, network monitoring system, network back-feeding and flexibility and reduced travelling time etc.

The practise of re-interruptions will result in a statistical step increase in the current SAIDI levels and a statistical step decrease in the current SAIFI levels of a distributor licensee. This will result in a reported SAIFI and SAIDI values that are more accurate and controllable via appropriate improvement or mitigation strategies to be implemented. This will require the recalculation of historical data and the recalibration of targets to reflect the adjusted data.

11. Pre-arranged Planned Interruptions

A planned interruption shall be categorised as a "pre-arranged" when an item of plant or section of network is deliberately and in a co-ordinated manner, taken out of service (by the distributor licensee or its appointed agent) at a selected date and time. All the affected customers shall have been notified of the planned interruption in accordance with the minimum period prescribed in NRS 047, or as otherwise contractually agreed.

Planned work is usually for the purposes of construction, preventative maintenance, refurbishment or repair. Currently NRS 047 specifies a 48 hours planned interruption notification time for customers.

When the planned and co-ordinated interruption of supply to the customer or group of customers involves a number of successive switching operations resulting in numerous interruptions, then the interruptions are all counted as a single planned interruption.

There needs to be a clear separation of the technical performance and quality of service related measures. The technical performance measures are based on the actual supply interruption times experienced by the customers.

The quality of service measures are based on the scheduled interruption time by the licensee, that the customers are surveyed on in terms of their satisfaction. A measure of the number of planned interruptions finishing later than the notified time can be established in NRS 047 to provide a measure of the distributor licensee's quality of service provided.

12. Customer Network Link (CNL)

Data connectivity refers to complete and accurate model of the number of customers connected to a transformer affected by an interruption. The process of connectivity refers to the ability of the system to infer the interruptions onto all the affected customers (even those customers who did not call in) from the

HV system to LV customers connected to MV/LV transformers, from data related to the received calls or the location of the affected device on the network. Allow for an accurate and complete customer connectivity model from the HV system to the LV customers connected to the MV/LV transformers.

The customer connectivity model shall be maintained and updated regularly by the distributor licensee. The connectivity model should have the following recommended end state minimum data accuracy and completeness levels :

- HV customers : > 99% of all HV customers accurately linked
- MV customers : > 95% of all MV customers accurately linked
- LV customers connected to MV/LV transformers : > 75% of all LV customers accurately linked

The above mentioned percentages are based on the end state. It is recognised that licensees may not be at the current completeness levels and will require time to reach the required levels of completeness.

The distributor licensee needs to justify to the NERSA about the appropriate and practical required customer connectivity levels for HV, MV and LV customers. The distributor licensee will need to justify to NERSA for levels less than the above recommended levels based on their particular operating environment, business circumstances and resource constraints etc.

13. Accuracy Guidelines of the Annual Interruption Measures Reporting

The accuracy of the network interruption performance measures will be critical in future IBR environments and annual regulatory reporting. The information below will apply once the systems are functional and there is confidence in the reported measures.

The distributor licensee shall be required to have a minimum accuracy level of 95% for the number of customers interrupted and 95% for the duration of interruptions of supply.

The accuracy levels apply to both HV and MV connected customers that experience sustained interruptions. It is a requirement that both the accuracy levels for the number of customers interrupted and the duration of interruptions of supply, are met by the licensee.

The distributor licensee is to ensure the appropriate levels of completeness and accuracy of the levels of interruption performance reported. This can be determined by an audit at the end of each reporting period. The distributor licensee shall be required to have the customer network link greater than or equal to 95% in the reporting period.

The initial accuracy level of 95% may be relaxed to take into account the current data connectivity model and data maturity of the licensee. It is proposed that the licensee conducts a self audit annually, but this may become a future regulatory requirement. The reporting accuracy levels will be critical once IBR is implemented.

The accuracy levels of HV and MV networks required may be increased in future regulatory requirements. It is also possible that accuracy levels for LV networks and for momentary interruptions are introduced in the future.

14. Customer Categories

The following type of customer category descriptions and relevant information shall be reported on (the type of customer affected by the interruptions) :

a) Residential customers (large)
Customers that use electricity at their place of residence and typically have an ADMD > 1. (This includes customers that work from home.)

b) Residential customers (small)
Customers that use electricity at their place of residence and typically have an ADMD ≤ 1. This type if customer is normally funded from the National Electrification Fund or similar government grants and cross subsidies.

c) Agricultural customers
Customers that use electricity for the purpose of economic activity related to agriculture. (I.e. farming and mostly include supply to house holds.)

It is recognised that there may be a hybrid urban agriculture customer category. This typical would be subsistence farms, fish farming and topical city initiatives (i.e mushroom and worm farming)

d) Industrial customers
Customers that use electricity for the purpose of industrial production, mostly situated in declared industrial areas. This category includes mining related customers.

e) Commercial customers
Customers that use electricity for the purpose of trading activities. Normally situated in declared commercial areas. (including tourism, retail, banking and education)

The customer category descriptions are intentionally broad to accommodate the majority of customer types in South Africa. The distributor licensee's may use more exact definitions to better suit their business, as long as they align with the broad customer descriptions above. This is to ensure uniform and consistent customer interruption reporting in South Africa.

The interruption performance levels per customer categories are a long term regulatory reporting requirement as part of an effective and value adding incentivised regulation approach. The customer database of the distributor licensees will need the customer category identified and recorded for reporting. The relevant timelines and compliance level required for distributor licensees to start recording and reporting customer categories, will be decided by NERSA in consultation with all the relevant Distribution stakeholders.

15. Classification of Major Events

A major event is considered to occur when there are conditions or events on the network that result in many customers affected, or a significant amount of installed MVA lost (installed transformer rating), or results in supply restoration times longer than that expected under normal conditions as specified in criteria A and B below.

The major events for MV networks as defined below, shall be removed from the network interruption performance indices and reported separately by the distributor licensee. The intention is to report the actual underlying performance level that is not distorted by abnormal events occurring that are out of the distributor licences control. The distributor licensee shall proactively manage both the underlying performance related interruptions and the abnormal performance related interruptions.

15.1 Major event criteria A (for annual regulatory reporting and distributor licensee comparison on a national basis)

An unplanned interruption shall be categorised as a "major event" for distribution comparison reporting purposes, where any one of the following conditions are met :

a) More than 50 000 customers are affected and are without supply for 24 hours or longer due to a single event

b) More than 50 MVA of the aggregated HV supply side ratings of the downstream installed transformer capacity and off for 24 hours or longer

The firm transformer capability or redundancy needs to be removed for condition b) above to prevent double counting and only the supply side transformer capacity used in the MVA calculation.

The major event criteria A uses a fixed quantum that will allow for equitable and consistent comparison of small and large distributor licensees in South Africa. Some of the larger distributor licensees may report many major events according to criteria A, due to the large customer base or large installed MVA. Some of the smaller distributor licensees may report a few number of major events. The intention is to normalise the major events for large and small distributors and provide a consistent national picture.

15.2 Major event criteria B (for annual reporting and year on year licensee performance tracking and self comparison)

An unplanned interruption shall be categorised as a "major event" for reporting where any one of the following conditions are met :

a) More than 10% of the installed customer base of the distributor licensee is without supply for 12 hours or longer

b) More than 10% installed MVA transformer base of the distributor licensee is without supply for 12 hours or longer

c) Through a specific agreement in writing between the relevant distributor licensee and the NERSA and that is published on the NERSA website in the public domain.

This criteria will allow for the aggregation of South African statistics and assist in determining the underlying performance trends for regulation purposes.

The major event criteria will be applied as per the formal areas of distribution of each distributor licensee. For example, in Eskom Distribution the major event criteria will be applicable to the individual regions.

16. Worst Served Customers Measures

The worst served customer related indices ensure that the network interruption performance levels experienced by the individual customers are still within the reasonable expected performance levels. The objective is to report reliability and availability of supply trends as per the three measures below, that are reflective of the network interruption performance of the individual customers. This includes planned and unplanned components.

It will be necessary to determine the following indices :

- Percentage of customers with single supply sustained interruptions of longer than a specified number of hours per annum per event.
- Percentage of customers experiencing more than a specified number of sustained interruptions per annum.

The sustained interruption calculation definitions and calculating method of shall be applied. The quantum for the above need to be established by the relevant licensee in consultation with NERSA.

The distributor licensee is accountable for the effective management of its poor performing networks or worst served customers.

17. Interruption Cause Code Categories

17.1 Introduction

This section presents a minimal set of data codes and a consistent categorisation structure necessary for interruption cause code collection, reporting and the comparison of distribution network performance in South Africa.

There are 15 identified primary cause codes (A to O) and corresponding secondary cause codes to provide high level information about the cause of supply interruptions, ensure a common interpretation, and assist in the uniform and consistent reporting amongst all the distributor licensees.

Broad categories were intentionally established to help minimize data collection efforts by the distributor licensees. There are numerous other categories that could be selected, but with the goal of uniformity and simplicity for comparison purposes and practicality, the above primary and secondary cause codes were selected. Allowance is made for those causes not covered (other category) and those causes that are unknown (unknown category)

17.2 Overview of Categories

The primary cause of supply interruptions shall be categorized as follows :

A : Equipment failure
A1 : Cable circuit (including any terminations to lines or other circuits)
A2 : Overhead line (including associated equipment, but excluding transformers)
A3 : Transformer (including tap-changers and voltage regulators)
A4 : Reactive control devices (capacitor, reactors)
A5 : Switchgear
A6 : Terminal equipment and busbars and related terminal equipment
A7 : Protection system failure (fuse failure)
A8 : Control system failure (SCADA)
A9 : Other

The distributor licensee may have sub-levels of the above high level categories

B : Planned work
The planned work category includes all interruptions that are planned.

C : Operational causes
C.1 : Incorrect protection operation (settings / fuse sizing)
C.2 : Incorrect control equipment operation
C.3 : Licensee operator error or licensee's contractor error
C.4 : Emergency

D : Supply intake (non-distributor licensee caused)
D.1 : Loss of supply due to technical problem
D.2 : Loss of supply due to non-payment

E : Vegetation
The vegetation category includes interruptions caused by falling trees and growth of trees into lines. It should be noted that if a tree is involved, the cause category is Vegetation. This is important to note during wind storms. It may not be possible to determine that a network may have a forestry issue if wind is listed as the cause when actually a tree was involved Interruptions caused by the combination of wind and vegetation shall be recorded under this category.

F : Fire
F.1 : Sugar cane fires
F.2 : Veld/bush fire .

G : Natural Events
G.1 : Storm (lightning / wind..)
G.2 : Snow/ice
G.3 : Significant events (earthquakes and tornadoes)

H : Insulation Pollution
H.1 : Industrial
H.2 : Natural (e.g. salt air, excluding bird)
H.3 : Fire-related
H.4 : Other

I : Wildlife
I.1 : Birds (physical contact/bird streamers/pollution etc)
I.2 : Other

J : Customer

K : Theft and vandalism

L : Third party
Including cables ripped/dug up by contractors or collisions

M : Unknown
The unknown category includes any interruptions where a definitive cause cannot be determined even after a formal investigation. The distributor licensee shall provide a brief description of each interruption assigned to the other category. The number of interruptions classified as unknown shall be kept to a practical limit.

O : Other
Any interruptions that do not fall into any of the above primary cause code categories should be assigned to the other category. The distributor licensee shall provide a brief description of each interruption assigned to the other category.

17.3 Application of codes

The proposed interruption cause code hierarchy is not a detailed or formal root cause analysis tool, but only a high level tool to categorise the causes of interruptions into logical and systematic categories to assist with identification of potential problems areas and the application of mitigation projects or improvement initiatives.

The interruption cause code categories will assist in future interruption performance benchmark exercises, so it is critical that accurate and reliable data is captured by the distributor licensees.

18. Annual Regulatory Reporting

When providing interruption performance data, the exclusion of any categories of interruptions shall be clearly specified by the distributor licensees with the submission to NERSA. It is anticipated that NERSA will clearly define which categories need to be included or excluded in the reporting requirements.

The annual reporting shall be on a calendar year basis. Annual reporting in the case of all licensees ensures that common events that affect various licensees are reported and consolidated or the industry by NERSA for the same period.

18.1 System interruption performance statistics

The following network interruption performance information shall be reported by the distributor licensee as part of the future annual power quality (PQ) report to NERSA :

a) SAIFI

b) CAIFI

c) SAIDI

d) CAIDI

e) MSLI

f) HSLI

g) Interruptions/100km (overhead and underground networks reported separately)

h) MAIFI

i) MAIFIe

j) MInterruptions/100km (overhead and underground networks reported separately)

k) Worst served customers

m) Customer supply restoration times

n) Number of major events occurring, the impact of the major event on the indices and the supply received by the affected customers in a geographical area and the comprehensive investigation report dealing with the cause of each major event

o) Number of voluntary and involuntary load reduction events and the relevant information of each event

Note that the system level performance reported needs to be the customer weighted average of the relevant districts or areas

The above reported interruption performance indices shall be reported separately as per the following categories :

a) Unplanned interruptions

b) Planned interruptions

c) Overall performance (unplanned, planned components and HV and MV combined)

d) HV (where applicable)

e) MV (where applicable)

f) 33kV (where applicable)

g) The interruption performance including and excluding major events as per category A

h) The interruption performance including and excluding major events as per category B

18.2 Categories for exclusion

The following shall be excluded from interruption performance indices, but the relevant information reported about these categories separately :

a) Customer caused and requested interruptions

b) Intake supply related interruptions

b.1 Non-load shedding related

b.2 Load shedding related

18.3 Technical commentary and cause codes

The following additional key information is also required to be reported :

a) Technical commentary report on the network interruption performance levels and explanation of any poor performance with the relevant action plans or initiatives to improve the performance

b) The interruptions experienced per cause code with a high level pareto analysis and technical commentary.

18.4 Reporting for incentive based purposes

Reporting for incentive-based purposes shall be agreed between NERSA and the licensee – but is likely to be on a financial year basis or linked to tariff application periods.

The NERSA will determine, in consultation with the distributor licensees, which network interruption performance indices are to be used in the incentive based regulation. The following shall be excluded from the interruption performance indices reported :

a) Major events (reported individually)

b) Intake supply related events

c) Customer related events

d) Voluntary and involuntary load reduction cause interruptions

e) Customer caused or requested interruptions

The planned and unplanned component interruption indices shall be reported separately to encourage the correct behaviour of the licences in managing the network faults and planned work program.

19. Local and International Benchmarking

Caution needs to be exercised when conducting network interruption performance benchmark exercises. Interruption performance benchmarking requires careful consideration of not only the physical conditions related to the peer group members (e.g. network type and topography, environment, geography, network operating practises and human resource related elements), but also of the measurement, data collection and storage and reporting methods used.

Through specifying the latter (taking international practises and key developments into consideration), the NRS 048-6 standard aims at providing an improved basis in South Africa, for undertaking such internal and international benchmarking activities into the future.

The NERSA needs to compare "apples with apples" for accurate and reliable interruption performance reporting and possible benchmarking between the distributor licensees in South Africa and potentially with international distributor licensees. This document will also in the long term, assist in determining which best work practices and processes the distributor licensees should implement, to improve their interruption performance to acceptable levels (and increased customer satisfaction).

20. Conclusion

The NRS 048-6 standard provides a solid framework for the future requirements of network interruption performance measurement and reporting in South Africa. In particular, the anticipated implementation of Incentive Based Regulation (IBR) will require accurate and consistent reporting methods and accurate and complete data collection, to facilitate appropriate target setting.

It is recognized that present systems (SCADA coverage and interruption databases and systems) of the distributor licenses do not meet the minimum requirements specified in this standard and that there are also resource and financial constraints.

It is recommended that the initial implementation of this standard will require a phased in approach (3-5 years) and that NERSA will specify the timeframe and compliance level for such implementation, in consultation with the various Distribution industry stakeholders.

It is also recommended that NERSA establishes an industry committee (similar to the previous NER PQ Advisory Committee) of all the relevant role-players in the distribution industry to ensure common understanding of the key principles, provide a forum for the discussion of the implementation of this standard.

The challenge is now for the distributor licensees to implement the NRS 048-6 standard and start improving their electricity service delivery – reliability and availability of supply.

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References

[1] NRS 047-1 : Quality of service

[2] NRS 048-2 : Voltage characteristics, compatibility levels, limits and assessment methods

Biography

Baden Chatterton graduated with a BSc(Eng) degree in Electrical Engineering (1997) and a MSc(Eng) degree (cum laude) in Electrical Engineering (2002) from the University of KwaZulu Natal. He joined the Eskom Distribution Division in 1998 and in 2002 was registered as a professional engineer.

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