



INTEGRAL ENERGY POWER QUALITY CENTRE NEWSLETTER

August, 2004

No. 10

New Agreement and New Name – The Integral Energy Power Quality and Reliability Centre (IEPQRC)

In 1996 Integral Energy provided funding to set up Australia's first Power Quality Centre. Since its inception the Centre has gone from strength to strength over the years with renewed support from Integral Energy thus gaining widespread national and international recognition. Over this period the Centre has received over \$1,000,000 from Integral Energy to meet a number of objectives set out in the agreements.

From July 2004 Integral Energy has committed to provide nearly \$300,000 per year for another three years to facilitate the expansion of the Centre to focus on distribution system reliability in addition to power quality. The funding allocation covers two full time academic positions, where one position is continuing from the last agreement. This will provide an opportunity

for the University to provide stronger power engineering education at the undergraduate level in addition to engaging in R & D in both power quality and reliability.

In addition to these activities, the Centre will also engage in:

- training the electricity supply industry, customers and the community in various aspects of quality of supply
- providing consulting services to the electricity supply industry, customers and the community
- providing informed and credible input to the development of national and international quality of supply standards
- providing informed and credible input to regulatory bodies

Introductory Power Quality Course given in New Zealand

In June, staff of the Integral Energy Power Quality Centre (IEPQC) presented a 2-day introductory power quality course to engineers and technical officers from a number of New Zealand generator and lines companies, and several others from electricity industry service/support organisations such as consultants, manufacturers and academics, 23 participants in all. The course presentation was commissioned by the Electricity Engineers' Association of New Zealand to be delivered the two days prior to its annual

conference and trade exhibition in Christchurch.

The aim of the course was to give a broad appreciation of power quality disturbances, their causes, effects and mitigation. The course was presented by Professor Vic Gosbell, Dr. Sarath Perera and Dr. Vic Smith of the IEPQC, plus two industry consultants who are also Visiting Professors of the University of Wollongong, Dr. Robert Barr, Principal of Electric Power Consulting, and



University of Wollongong



Dr. David Sweeting, Principal of Sweeting Consulting Services.

Professor Gosbell started with an overview of power quality disturbances, their classification and principles of management. He later discussed the issue of harmonics, gave a presentation on national and international standards relevant to power quality and looked at power quality monitoring issues. Dr. Perera discussed the behaviour of modern electrical loads, how they are affected by power quality disturbances and how they can cause power quality problems. He then dealt with long duration voltage variations, voltage unbalance, issues concerning the application of power factor correction capacitors, and voltage fluctuations and flicker. Dr. Smith

gave a summary of modelling and calculation methods useful when dealing with power quality problems, then later lectured on transient overvoltages, and voltage sags and interruptions. Dr. Barr presented an overview of current power quality issues relevant to the electricity supply industry then discussed the importance of protection settings when dealing with voltage sags. Dr. Sweeting gave a series of case studies explaining how to deal with voltage sag problems in industrial plants. The course finished with an open discussion forum.

The course was well received by participants and there appear to be further opportunities for power quality training in New Zealand in coming years.

EWP Project

Elevating Work Platform (EWP) units have become an integral part of the routine operations of distribution network service providers including maintenance and repair of live overhead power lines. EWP units have historically been operated using hydraulic controls and actuators. Hydraulic control lines within EWP booms are sometimes prone to gradual build up of contaminants (dirt, oil, etc.) compromising their insulation integrity. To increase insulation integrity, and also to allow other safety features to be incorporated, EWP units are now being operated via radio control.

The Australian Strategic Technologies Program (ASTP) arm of the Energy Supply Association of Australia (ESAA) is currently investigating the integrity of EWP radio control. The Power Quality Centre has contributed to the investigation by completing an extensive review of existing research literature, standards, and product specifications with regards to the security of operation of elevating work platform radio control units. Assoc. Prof Tad Wysocki, the

resident expert in the radio communications field at the University of Wollongong, assisted with the investigation.

The project reported on the likelihood of electromagnetic interference derived from the currents and voltages existing on live overhead power lines occurring at frequencies within the 400-500MHz frequency band used by the EWP radio control unit transmitters and receivers, and also the possibility of radio interference from unlicensed communication devices sharing the same frequency band.

The ASTP is currently considering utilising the services of the Power Quality Centre to complete a more in-depth investigation involving field measurements of background electromagnetic interference at the relevant frequencies in order to establish a typical type test which would allow EWP manufacturers to ensure the integrity of the radio communication systems prior to operation in field situations.

CIGRE/CIRED Joint Working Group C4.1.03

This Working Group has the name "Emission Limits for Disturbing Installations" and a major task is to review the prime harmonic and flicker standards IEC 61000-3-6 and IEC 61000-3-7. It is chaired by Germain Beaulieu of Hydro Quebec. Australian members are Alex Baitch (full) and Vic Gosbell (corresponding).

Vic Gosbell attended the meeting held in March in London where discussion concentrated on IEC 61000-3-6. The Standards Australia Handbook HB 264-2003 was circulated to all members and a presentation given on its underlying principles.

This committee members are mainly from the transmission industry and this has determined the methodology of the standard. Transmission aspects are complex, because of

the effect of line capacitance and the range of variables which need to be handled. There is as yet no generally accepted rigorous methodology, only a number of pragmatic approaches. For this reason, this standard is likely to remain a Type III Technical Report in its next edition, that is one which contains some useful data of a type not normally published as a standard.

Likely changes in the standard are:

- Removal of the first summation law since it is hardly ever used
- Change in the statistical indices used to evaluate harmonics (but 3 second values are likely to be still used)
- Addition of a section from HB 264-2003 showing harmonic allocation to distribution systems where there are long feeders.

Electromagnetic Coupling Issues associated with Transmission Lines and Gas Pipelines in Shared Corridors

Voltages can occur on gas pipelines due to the presence of power transmission lines in their common right-of-way. These can be due to both load current and fault current in the transmission lines and can affect the safety of construction and maintenance personnel and interfere with the operation of cathodic corrosion protection systems.

The Integral Energy Power Quality Centre (IEPQC) has been working with the gas infrastructure company Agility and the Co-operative Research Centre for Welded Structures to examine the level of voltage produced on some specific gas pipelines. The IEPQC was asked to participate because of its expertise in monitoring of power quality disturbances which could readily be applied to the voltage measurements required for this project. Two Hioki 3196 Power Quality Analysers have been connected to a section of one pipeline, each at a transformer-rectifier (TR) station used for cathodic protection. The

TRs are periodically disconnected from the pipeline to allow measurement of induced/conducted voltages. In conjunction with these measurements it is intended to connect a Dranetz-BMI PowerXplorer PX5 Power Quality Analyser to the transmission feeder involved so that voltages measured on the pipeline can be correlated with the current measured on the feeder. Negotiations are still continuing with the transmission authority to allow this to happen. In the meantime, currents logged by the transmission authority at 30 minute intervals are being used.

To complement the voltage measurements, a ME (Research) student is performing theoretical studies into the voltages produced under steady state and fault conditions, and will examine the effect of these voltages on the operation of the cathodic protection systems which protect the pipeline from corrosion. In particular the operation of TR units will be looked at for a range of conditions.

AUPEC 2003 Paper Abstracts

1. Allocating Harmonic Emission to MV Customers in Long Feeder Systems

V. GOSBELL, D ROBINSON

Previous work has attempted to find satisfactory methods for the allocation of harmonic current emission MV subsystems containing long feeders. It has been proposed that best use of the network's harmonic absorption capacity is made if the allocated current varies with the inverse square root of the harmonic impedance at the point of connection. It has been shown that an exact solution following this principle requires an impracticably large amount of data. Here it is assumed that each feeder supplied from a given substation has its load distributed uniformly and continuously along it, giving equations requiring only a modest amount of data. It is demonstrated by means of a suitable example that the method is sufficiently accurate for practical situations where loads are lumped non-uniformly.

2. Harmonic Planning Levels for Australian Distribution Systems

V. GOSBELL, V. SMITH, D. ROBINSON, W. MILLER

A modeling technique is developed for determining the harmonic voltage distribution across a distribution when there is an equitable distribution of harmonic emission. The harmonic voltages at the 132kV and 415V levels are fixed to values based on IEC Compatibility and Planning Levels and the intermediate voltages determined. Studies are made of six systems, typical of Australian distribution practice, to examine the effect of choice of voltage level and system parameters over the harmonic range of 2-40. Based on the study, harmonic planning levels are recommended for application to Australian distribution systems.

3. Allocation of Harmonic Currents to Customers in Meshed HV Networks

T. BROWNE, V. GOSBELL, S. PERERA

Use of the new harmonic standard AS/NZS 61000.3.6 to determine legally and technically defensible harmonic current limits for an interconnected transmission network ought to be feasible. But for various reasons, application of this standard to even a simple radial network, let alone a relatively complex meshed transmission system, is a highly non-trivial exercise. Further, the allocation procedure proposed by AS/NZS 61000.3.6 is shown to deliver harmonic current allocations that result in harmonic bus voltages which exceed utility planning levels. A new method has been developed, whereby harmonic voltages at network busbars are explicitly forced to be at or below utility planning levels when all loads are injecting their maximum permitted harmonic currents derived under the allocation. This new method is shown to give suitable and strictly equitable harmonic allocation for a simple three-bus sample transmission network.

4. MV Distribution Voltage Sag Limits for Network Reporting

C. HERATH, V. GOSBELL, S. PERERA

Suitable voltage sag objectives are not yet found in any standard document. One of the reasons for the lack of objectives is the difficulty of defining suitable site sag indices. In this paper present sag characterization methods are reviewed and discussed. The University of Wollongong sag index is summarized which shows a better way of characterizing voltage sags. A new method is then given for defining MV distribution sag limits and their suitability is shown by an examination of sag data for some Australian sites.



5. Issues Affecting Power Engineering Undergraduate Education in Australia

D. ROBINSON, V. GOSBELL

Recent changes to the electric power industry through deregulation and restructuring have had a considerable effect on power engineering education internationally. A number of Australian universities have also noticed a decline in the number of students interested in power engineering subjects, leading to fewer graduates with power engineering knowledge. With a reduction in graduates and a perception of an aging workforce a shortage of suitably qualified power engineers for industry may be imminent. This paper provides discussion on the current status of university power engineering education within Australia and includes results from a recent Australia-wide

survey of the university and industry sectors of electric power engineering.

6. Possible Measurement Errors in Relation to Harmonics and Flicker

J. BRAUN, V. GOSBELL, S. PERERA

The measurement of harmonics and flicker in the MV and LV systems can be made either line-to-line or line-to-neutral. Standards provide little guidance on this. As the choice is left to the operator, it may result in some discrepancies in the reporting for compliance. This paper investigates the possible errors between the two measurements in relation to harmonics and flicker in the situations: (i) a large single phase MV load and (ii) the normal variation in LV systems due to lack of perfect balance across the phases. The problem is first analysed theoretically and then supported with field measurements.

EESA 2003 Paper Abstracts

1. New Concepts for a Voltage Sag Immunity Standard

R. BARR, D. SWEETING, V GOSBELL

The need for new standards to address voltage sags is becoming increasingly urgent due to increasing numbers of susceptible customer electrical appliances and digital systems. The IEC has produced a draft standard 61000-4-11 - Electromagnetic compatibility (EMC) - Part 4-11 : "Testing and measurement techniques - Voltage dips and short interruptions immunity tests"[1]. This draft standard in the opinion of the authors is deficient in that it proposes voltage sag performance levels that are effectively not achievable by electricity distribution networks because of the fundamental constraints of network and protection schemes and the impact of customers. This paper describes new concepts in defining, measuring and characterising voltage sags and equipment voltage sag immunity that can form the basis of producing a new standard. The proposed new techniques have the potential to greatly assist the electricity industry, electricity customers and manufacturers.

2. Supply Industry Code for Control of Power Quality

V. GOSBELL, V. SMITH, P McMULLAN

This paper will discuss the principles which should make up a supply industry code so that power can be held within specified limits.

Variations from the ideal voltage waveform can be categorized into a large number of headings of which the principal ones are voltage deviation, unbalance, flicker, harmonics and sags. These disturbances need to be limited to reduce problems, maloperation and losses within both customer installations and the network.

Problems occur when there is a mismatch between the level of PQ disturbances on the network and the immunity level to which equipment is designed. The level of disturbances is a function of:

- Utility practices and operations
- MV customer installation design and operation
- LV customer equipment emission levels

Acceptable power quality requires each of the above parties to take on an appropriate responsibility in regard to emission or immunity. The supply industry, with its central role and breadth of technical knowledge, is well placed to coordinate the development of a code which define these responsibilities and gives the necessary technical details.

The paper will discuss the issues which will need to be incorporated into a supply industry code to ensure that power quality remains acceptable. Some aspects that will be discussed are:

- Main role for the utility, customer and equipment provider
- Routine power quality monitoring as a means of checking average power quality and for feedback for improved management practices.
- Power quality agreements between utilities and large customers, with the upstream party giving an undertaking on voltage and the downstream party giving one on current.
- The need to have mandated control over equipment emissions to control LV network disturbance levels.

DISTRIBUTION 2003 Paper Abstract

1. Harmonics and Flicker Levels at a Sub-Transmission Substation: A Measurement Experience

D. ROBINSON, V. GOSBELL, S. PERERA, N. BROWNE

Proactive monitoring of power quality disturbance levels by electricity utilities is vital to allow cost-effective mitigation when disturbances are perceived to be approaching planning levels and also to protect the security of customer installations. Ensuring that disturbance levels are within limits at the HV and EHV points of supply of the network is

essential if satisfactory levels downstream are to be maintained. This paper presents discussion on a power quality monitoring campaign performed at the sub-transmission point of supply of a distribution network with the objective of benchmarking background disturbance levels prior to modifications to the substation and to ensure emissions from HV customers and the downstream MV networks are within acceptable levels. Some discussion on the difficulties involved in such a study is presented.

CIGRE/IEEE-PES International Symposium Paper Abstract

1. The Reporting of Distribution Power Quality Surveys

V. GOSBELL, A. BAITCH, M. BOLLEN

Power Quality surveys can contain a large amount of data for many sites and several utilities. A reporting format needs to be adopted with Site, Network and Utility component styles. The first of these is the presentation of the raw data in slightly

abbreviated form while the second allows all sites in one network to be ranked according to severity of their Power Quality disturbances. Utility reporting allows comparison between the overall Power Quality performance of different utilities in benchmarking studies. Some new data analysis algorithms are proposed to show how the reporting styles should be implemented.



CIREN 2003 Paper Abstracts

1. XML Schema for Power Quality Data

J. BRAUN, V. GOSBELL, D. ROBINSON

The introduction of deregulation and competition in the energy market has forced utilities around the world to focus on the improvement of both efficiency and cost effectiveness of their operations. Central to this aim is the need to integrate large amount of real time and historical data in order to extract the knowledge so essential for better decision-making. This amalgamation of data originating from various technical and business systems is known as Enterprise Application Integration (EIA) and will in the future include Power Quality (PQ) data. However, this requires the organization of data in a way that is consistent with the overall aim. This paper discusses this aspect and presents an XML schema for power quality data.

2. A Transient Index for Reporting Power Quality Surveys

C. HERATH, V. GOSBELL, S. PERERA, D. ROBINSON

Impulsive transients are often blamed for the destruction of customer appliances. Advances in Power Quality (PQ) monitors will soon make it feasible to incorporate impulsive transients into routine power quality surveys. This paper considers how the transient events captured over a period at many sites may be reported in a simple but useful manner. The

paper first summarizes a recent publication by some of the authors, which attempt to give a complete framework for the analysis of utility PQ data. This framework provides a basis for evaluating existing transient characterization practices as well as for the proposed new transient index that will be discussed in the paper. A review of current transient characterization practices and their limitations, followed by the development of new transient index for use in site ranking is given. The application of the new transient index is illustrated through an example.

3. A Study of Continuous PQ Disturbance Levels in MV/LV Distribution Systems

V. GOSBELL, D. ROBINSON

Distribution Network Service Providers need to be aware of the general variation of PQ disturbances across their network, from sites as diverse as the MV busbar of a zone substation, the end of a MV feeder, and at the near and far ends of LV mains. This paper develops an understanding of PQ variations across such a system from survey results correlated with approximate analysis used to assign a PQ disturbance ranking to each site. The work will concentrate on continuous PQ disturbances, defined as those due to load current effects, for example voltage deviations, unbalance, fluctuations and harmonics.

NEWSFLASH

This will be the last newsletter published under the Power Quality Centre name.

Our next and subsequent newsletters will be published under the new name of

"The Integral Energy Power Quality and Reliability Centre"

If you require further information about any article in this newsletter, please contact the Integral Energy Power Quality Centre, School of Electrical, Computer and Telecommunications Engineering, University of Wollongong NSW 2522, Australia. Fax: +61 2 4221 3236
Email: pqc@elec.uow.edu.au Internet: www.elec.uow.edu.au/pqc

