



# INTEGRAL ENERGY POWER QUALITY CENTRE

# NEWSLETTER

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## Power Quality Monitoring to Establish Utility Performance

On March 14, Prof. Vic Gosbell presented a lecture entitled "Power Quality Monitoring to Establish Utility Performance" at an IEAust, ITEES, IEEE Joint Meeting at Eagle House, Sydney. It was part of a "Dual Lecture" including a talk "Power Electronic Technology for Power Quality Improvement" given by Mr Saki, Senior Design Engineer/Manager of Toshiba's Fuchu manufacturing complex.

State regulators are making utilities more accountable for the levels of PQ disturbances on their networks. There is a trend to requiring utilities to install a PQ monitoring system and to give regular reports on system levels. Much work needs to be done in establishing practices that give the required information at low cost.

The disturbances of interest appear to be voltage, unbalance, harmonics, flicker, sags (and short term interruptions), swells and transients (both the slow oscillatory and the fast impulsive type). Much work needs to be done in developing a generally acceptable method for characterising these disturbances. Taking voltage as one example, the following questions need to be resolved

- Should every cycle be measured?
- What should be the period over which the measurements are averaged (e.g. 5, 10 or 15 minutes)?
- How should readings across three phases be combined, if at all?

- Should readings be taken during abnormal operating conditions, such as during recloser operation?
- What statistical measure should be calculated to summarise the readings over the survey period?

There are an enormous number of possible sites within a utility at which a monitor could be connected. Clearly this is impracticable and it is important to develop criteria that will allow a sensible subset to be selected. One issue is whether to monitor at MV or LV sites. The former gives better coverage of a larger number of downstream sites. However, many disturbance types are worst towards the end of LV distributors and it is significant that most PQ complaints come from LV customers. Maybe both types need to be represented. It is important that the selected sites represent all the significant factors influencing PQ. For example rural, urban and CBD sites must be represented in roughly the same proportions as they occur overall in the utility's network.

Smart tariff meters (STM) are now able to report on some aspects of PQ. If there are no barriers to making tariff meter information available, a cost-effective measurement system might consist of a few strategically placed PQ monitors providing high quality data supplemented by many existing STMs providing low quality data. Dataflows are potentially very large. It has been estimated that readings of the above disturbance types taken every 10 minutes, over 1,000 sites,



will lead to an annual build up of 9GB. This dataflow threatens to become a "data flood" unless suitable summary indices are found to give overall insights.

The monitoring system may consist of a variety of monitoring instruments, transducers, the provision of special power supplies, a communications system and a large database and reporting facility. The main rationale for the cost of this system is reporting of a few performance parameters to regulators. However, the amount of information in the database will be huge and it may be possible to extract valuable data for system planning and operation purposes at little additional cost. Trend analysis can reveal growing PQ levels

before they become a problem and allow a greater flexibility of response. Factor analysis can show which planning, operation and maintenance practices correlate with low PQ levels and aid the development of PQ management.

The PQ Centre (PQC) will be researching the above issues as part of its project "Power Quality Survey and Monitoring Methodologies for the Australian Electricity Distribution Industry" funded under the Commonwealth SPIRT scheme (reported in Newsletter 5).

Prof. Gosbell has been asked to repeat his presentation at IEAust's Brisbane Headquarters on May 29.

## **Integral Energy Power Quality Centre to be renewed for another triennium**

The PQC was founded in 1996 and is presently operating under an agreement with Integral Energy which expires at the end of June this year. Integral has recently announced that it will fund the Centre for another three years and a new agreement is being drafted at present.

Although details have yet to be finalised, a new feature will be the setting up of a power engineering lectureship at the University of Wollongong. This action is very much appreciated at a time when university power engineering appears to be

in decline in Australia. Industry is having difficulties in obtaining new graduates and the IEAust is sufficiently concerned that it is setting up a study to identify the magnitude of the problem, causes and possible remedial actions (see report appearing later in this Newsletter).

The balance of Integral funding will be used to cover the operating costs of the Centre and a component of the salary of a research engineer. The remainder of the research engineer's salary will be found from additional consulting.

## **Visit of New Zealand power engineering professor to the PQC**

Pat Bodger, Professor of Power Engineering with the Electrical & Computer Engineering department, University of Canterbury, New Zealand visited the University of Wollongong for April 11 and 12. Pat has replaced Jos Arrillaga who had been professor for many years previously and is well known in the power quality community for his work on harmonics. Pat's research interests include,

among many things, the reverse design of transformers, and disinfection and deionisation of water using AC high voltage. He is strongly concerned about the future of New Zealand power engineering education and is planning to set up the Canterbury University Centre of Excellence in Power Engineering in collaboration with Transpower and other industry partners.

His visit to Wollongong was concentrated within the School of Electrical, Computer and Telecommunications Engineering. One day was spent with Professor Cook's Superconductivity Applications Research Group. His remaining day was spent with members of the PQC, discussing research projects and items of more general interest, such as our experience with the Integral Energy PQC and the state of power

engineering education in Australia. We are attempting to form closer links between members of the Power Groups at the two universities.

Professor Bodger is planning to attend the next AUPEC (Australian Universities Power Engineering Conference) to be held at Monash University in late September.

### **Integral Energy Training Course – Introduction to PSCAD/EMTDC**

The third training course for Integral Energy technical staff was held on 4<sup>th</sup> April at the University of Wollongong at which about 26 participants were present. The course was introductory in nature to cover the basic aspects of the well known power systems electromagnetic transients simulation software package PSCAD/EMTDC. The course began by getting to know the basics through an already developed exercise followed by a problem covering the use of circuit breakers, control panels and meters. A specific exercise was provided to introduce

the setting up of transformers in simulations followed by a capacitor switching transient exercise. An exercise was also set to examine the behaviour of single phase rectifier systems distributed in a three phase system and the build up of neutral current. The resulting harmonics of the line and neutral current was examined using the on-line frequency scanner. A number of additional example exercises were provided for the participants to work through at their own leisure by downloading the personal edition of PSCAD/EMTDC from [www.hvdc.ca](http://www.hvdc.ca).

### **Book Review: Electrical Transmission and Distribution Reference Book**

ABB Power T & D Company Inc., Raleigh, North Carolina, Fifth Edition

This reference is a reprint of the well known Westinghouse Transmission and Distribution Reference Book which has not appeared in a book store for nearly 2 decades or so. For those who are eager to get their hands on this famous Westinghouse book, here is the opportunity.

The only difference between this edition and the last edition which was printed in 1964 is the 25 page long new Chapter 24 covering the topic 'Characteristics of distribution loads'. In addition to the print form the book also comes with a CDROM

that provides the entire volume of the book in PDF form, making searching very easy.

Those who are new to the book will find this publication to be a wealth of material. The knowledge resulting from many years of experience of practicing power systems engineers and researchers are very finely discussed in the book in addition to basic topics such as symmetrical components and power system stability. However, it is unfortunate that the book does not delve into power system issues and the new technologies that have undergone a tremendous amount of research and development over the last 25 years or so.

## Introductory Power Quality Course

The Power Quality Centre will be holding an introductory power quality course from 26 to 28 June 2002 at the University of Wollongong on behalf of the Electricity Supply Association of Australia (ESAA).

The course will give a practical understanding of the principles, practices and problems associated with supply quality, and will cover all power quality problems including voltage sags, harmonics, transients and light flicker. Participants will learn analysis fundamentals, instrumentation techniques and methods of improving power quality by both network and plant modifications. The course will largely follow the text book "Electrical Power Systems Quality" by Dugan, McGranaghan and Beaty, and this will be distributed to all participants together with copies of all lecture slides. A feature of the course will be a number of hands-on computer investigations for "what-if" scenarios. Course participants will have the opportunity to develop their knowledge and skills through discussion and group work sessions.

The course is designed for managers, utility specialists and senior technical staff who wish to advise customers on power quality concerns, or who service large customers or who wish to understand

aspects of network design, construction and maintenance techniques for maximising quality of supply. Personnel working in all areas of power system design who wish to know how the system interacts with the end-user will also gain from this course.

The practical nature of the course is enhanced by presentations from a number of industry speakers including Mr. Alex Baitch, Manager - System Development for Integral Energy who has extensive experience in power system engineering and quality of electrical supply, Dr. David Sweeting, principal of Sweeting Consulting Services specialising in HV electrical distribution and power quality reviews for distributors and customers, and Dr. Keith Walshe, principal of Power Quality Technologies Pty Ltd who specialises in electric power quality analysis and problem resolution including the application of harmonic filters. Both Dr. Sweeting and Dr. Walshe are Visiting Professors of the University of Wollongong.

A brochure with registration details is available for download in PDF format from the Centre's web site (<http://www.elec.uow.edu.au/pqc/>).

## Technical Notes published by the Power Quality Centre

The Power Quality Centre has published a number of Technical Notes over the past few years. These have dealt with a range of power quality topics and are available for download in PDF format from the

Centre's web site (<http://www.elec.uow.edu.au/pqc/>). A list of available Technical Notes is given below.

TN#1	"Understanding power quality"	June 1998
TN#2	"Power factor correction and its pitfalls"	May 1999
TN#3	"Harmonic distortion in the electric supply system"	March 2000
TN#4	"Voltage sag measurement and characterisation"	June 2001
TN#5	"Power quality monitoring – plant investigations"	January 2002

## **IEAust power engineering survey**

It is perceived that the power industry in Australia is currently undergoing a shortage of skills, education programmes, and research and development projects. Such problems are reflected in the availability of suitable power engineers within industry and also in the number of undergraduates undertaking power engineering subjects at Universities. To address this issue the University of Wollongong, in conjunction with CHC Associates and the Institution of Engineers Australia, has formed a small consultative group.

The group is currently in the process of drafting a power engineering survey to establish the extent of the power industry problems, including vision and views of industry and educational institutions. The survey is to be distributed nationally to the power industry including utilities, engineering firms, consultants, contractors, major utility customers and educational institutions. The information from the survey will be used to develop detailed proposals to help rectify problem areas that are identified. The results will also be presented to both industry and government for discussion and support of any initiatives arising from the study.

## **Springhill transmission substation monitoring**

Integral Energy has recently proposed a major refurbishment of their Springhill transmission substation facility. The refurbishment includes the replacement of eight HV/MV transformers and associated circuit breakers. The Power Quality Centre was approached to investigate the impact of the refurbishment on power quality for customers fed directly from or via the substation. The existing customer loads are largely industrial, however the substation also feeds a significant amount of residential and commercial loads.

Harmonic voltage distortion and voltage fluctuation (flicker) levels were of most

concern for this study. A monitoring programme to establish the existing levels of disturbances was completed over a number of weeks during the months of March and April and results compared against the relevant standards (AS/NZS 61000.3.6 for harmonics, and AS/NZS 61000.3.7 for voltage fluctuations). The results from the monitoring programme have also been used to provide a qualitative estimate of the power quality disturbance levels following refurbishment. This project reflects the trend of utilities being more proactive in the area of power quality and associated effects on customer installations.