



INTEGRAL ENERGY POWER QUALITY CENTRE NEWSLETTER

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National Power Quality Survey

Over the past seven months, the Power Quality Centre, under contract to the Australian Power Quality Service Centre of the Illawarra Technology Corporation, has been conducting a national power quality voltage survey involving nine electricity distributors. This pilot survey is a first attempt at benchmarking the Australian electricity network and has been greatly supported by the Electricity Supply Association of Australia (ESAA).

For each distributor, eight sites at 240 / 415 V were chosen for monitoring for a one-week period. Four of these sites were selected because they were expected to be of average power quality and the other four were sites of poor power quality. Also the eight sites were chosen so that they represented different load types (i.e. residential, industrial, commercial, rural and remote), geographic areas and bulk supply points.

The quantities monitored were steady state RMS voltage, voltage unbalance (three-phase sites only), voltage harmonics (3rd, 5th and THD), voltage sags and interruptions, voltage swells, and transients. These were chosen because of their importance in Australian standards and state codes, especially steady state voltage. Sags are important because of their effect on contactors and variable speed drives which are a part of most industrial processes. Transients include capacitor switching oscillations and can affect electronic appliances, data processing equipment and industrial controls. Harmonic

voltages and currents can lead to increased heating of equipment with subsequent loss of service life. Also harmonic resonance situations can lead to major problems. Voltage unbalance is specified very tightly in some codes but there is potential for large values to occur unavoidably in some rural feeders leading to increased heating of three-phase induction motors.

In a survey of this type, it is important that the data gathered from the various measurement sites is accurate and consistent to allow comparisons. All survey measurements were undertaken with CHK Wireless Technologies POWERmonic PM30 instruments. These instruments were chosen because they have both logging and event capture capabilities, will measure or allow calculation of the selected power quality quantities, have battery-backed memory, are rugged and weather proof, and are locally manufactured, being readily available and well supported. These instruments were calibrated prior to commencement of the survey.

As well as benchmarking the electricity network, the Centre is actively working on using the measured data to develop power quality indices that will allow a distributor to quickly assess its network, determine type of power quality problems and where they are, so that suitable solutions can be applied.

The survey will be completed by the end of April 2001.



New Structure at Integral Energy Increases Focus on Power Quality Issues

A recent restructure of the System Development Branch of Engineering Performance within Integral Energy has resulted in the establishment of the Power Quality, Protection and Operational Analysis Section. The establishment of the section highlights Integral Energy's commitment to power quality issues, and is an acknowledgement of the importance of those issues to electricity distributors.

Among the main responsibilities of the Power Quality, Protection and Operational Analysis Section are the development of power quality standards for Integral Energy and the evaluation of new customer load applications to ensure their compliance with power quality standards.

The long standing relationship between Integral Energy and the Power Quality Centre is further strengthened by the new structure.

The partnering relationship of the Power Quality Centre will be used to aid in the development of workable power quality standards for Integral Energy's electricity distribution network, and in the refinement of evaluation methods for power quality assessment of new and existing electricity network configurations. The desire is to establish an increasingly pro-active approach to the evaluation and management of power quality.

The involvement of the Power Quality Centre in the investigation of power quality issues with the Integral Energy network, the development of potential solutions to those issues, and in the training and education of Integral Energy staff, are also expected to continue to develop with the new structure.

AUPEC 2000 Conference

Vic Gosbell, the Technical Director of the Centre, attended AUPEC (Australasian Universities Power Engineering Conference) in Brisbane in late September 2000 at QUT (Queensland University of Technology) under the Chairmanship of Prof. Gerard Ledwich. This Conference is held annually and is the prime annual power engineering conference in the Australasian region. The conference theme was "Innovation for secure power". There was an attendance of about 60 registrants with about the same number of papers being presented. This was the first AUPEC conference to incorporate workshops with brainstorming from a mixture of academics and industrial engineers. Workshop topics were Distribution Automation, Distributed Generation and Meshed Networks.

Vic presented three papers based on work undertaken by the Centre and these are discussed later in this newsletter. Other power

quality papers mainly concentrated on DSP aspects of monitoring such as the calculation of harmonics and the automatic recognition of different disturbance types.

There were three keynote speakers. Jack Taylor, Director of the Office for Sustainable Energy (Department of Mines and Energy, Queensland) spoke on "Renewable Energy in the Environmental Millennium". He concentrated on developments in Queensland, emphasizing the state's assets of sunshine, sugar, wind and water. Tim George of NEMMCO (National Electricity Market Management Company) spoke of managing power system security in the NEM (National Electricity Market). He defined security in this context and showed how it can be supported by on-line and off-line tools.

A talk on "Simulation of power system harmonic sources" was given by Jos Arrillaga, Professor Emeritus from University of

Canterbury, Christchurch, New Zealand. He made the point that one needs to get away from current source models for accurate harmonic studies such as required for the design of harmonic filters. More advanced analysis techniques include (i) transfer function approach, (ii) hybrid time and frequency domain method, (iii) harmonic domain model.

The conference concluded with a workshop on power engineering education and set up some working groups to report on various aspects at this year's AUPEC to be held at a similar time at Curtin University in Perth, Western Australia.

Ninth Intentional Conference on Harmonics and Quality of Power and visit to Manitoba HVDC Research Centre

Sarath Perera attended the Ninth Intentional Conference on Harmonics and Quality of Power which was held in Orlando, Florida during 1-4 October 2000. The conference was attended by nearly 180 delegates from around the world where nearly 200 papers were presented. The conference also had several tutorial and panel sessions dedicated to harmonic standards, and voltage sag analysis. A technical visit to the Siemens FACTS and Power Quality Plant added an extra dimension to the conference.

Sarath presented a paper entitled 'Establishment of Typical Harmonic Voltage Levels in Radial Distribution Systems' authored by D A Robinson, S Perera,

V J Gosbell and D Mannix of the Integral Energy Power Quality Centre of the University of Wollongong.

Prior to the conference Sarath also paid a special visit to the Manitoba HVDC Research Centre Inc. in Canada where the PSCAD/EMTDC™ Electromagnetic Transients Analysis software originates from. The visit enabled discussions on various issues in relation to the software and also to examine the power quality research that is conducted at the centre. RTDS Technologies located in the same premises was also paid a visit where there was the opportunity to see the largest real time simulator being commissioned.

Abstracts of Recent Conference Papers Produced by the Centre

1. "Harmonic Survey of an MV Distribution System", V. Gosbell, D. Mannix, D. Robinson & S. Perera, Australian Universities Power Engineering Conference (AUPEC 2000), Brisbane, September 2000.

Abstract: The harmonic survey of a medium voltage distribution system involves three major aspects: (i) the choice of harmonic monitor, (ii) the choice of monitoring site, (iii) processing and presentation of results. As well as a discussion of the methodology for these aspects, the paper will discuss the harmonic levels measured, the minimum survey requirements for finding useful data

and the harmonic parameters of residential, commercial and industrial loads.

2. "Establishment of typical harmonic voltage levels in radial distribution systems", D.A. Robinson, V.J. Gosbell, Member IEEE, B.S.P. Perera, Member IEEE, D.J. Mannix, Proc. International Conference on Harmonics and Quality of Power, Orlando USA, October, 2000, pp. 1053-1057.

Abstract: This paper reports on a simple method to identify problem areas with relation to harmonic distortion within radial distribution systems at the planning stage.

The purpose of the work is to produce a simple method of establishing harmonic distortion levels throughout a study distribution system when only limited system data and load information is available. The preliminary work presented in this paper is aimed at establishing useful planning guidelines for utilities to help with the analysis of harmonics in Medium Voltage (MV) distribution systems during the design phase. Harmonic analysis during the design of a distribution system is seen as an important step in controlling harmonic distortion levels.

3. "Investigation into the harmonic behaviour of multipulse converter systems in an Aluminium smelter", S Perera, V J Gosbell, D Mannix, AUPEC 2000, Brisbane, Sept 2000, pp.178-183.

Abstract: Modelling of diode rectifier systems in smelters and their impact on HV supply system is made difficult by a number of factors.

Such systems contain multipulse configurations and are connected to HV networks of large capacities, and their physical extent is difficult to gauge for modelling purposes. In the converter outputs, there are output current regulation techniques that are unique to these systems.

Modelling is also made difficult further by the uncertainty of the device and system parameters and the background disturbance levels especially as the pulse number of converters is high. The paper outlines the methodology adopted in an investigation at a smelter, highlighting the approaches taken to overcome some of the difficulties. Results of the simulation work carried out in both time and frequency domain are also summarised.

4. "Software implementation of power quality standards", V. Smith and V. Gosbell, AUPEC 2000, Brisbane, Sept 2000, pp.208-213.

Abstract: In recent years, equipment and network standards have been increasing in both number and complexity. Two standards

that will soon be introduced to Australia are the MV and HV standards for assessing distorting and fluctuating loads, AS/NZS 61000.3.6 and AS/NZS 61000.3.7, respectively. Utility engineers, being under increasing time constraints, are turning more and more to software to quickly solve problems. This paper describes the methodology used to implement the above standards in Microsoft Excel in order to assist utility engineers to readily apply these standards in practical situations. The assumptions and simplifications used in this implementation are described.

5. "Sag testing of dairy farm milking equipment", V.J. Gosbell, V. Smith, D.A. Robinson, B.S.P. Perera and R. Coulter, Proc. PowerCon2000, Perth, December 2000, pp.947-952.

Abstract: Sags are widely reported as being one of the worst power quality problems and are particularly common in rural areas. Automated milking equipment on dairy farms are thus very susceptible to malfunction by sags. In assessing the relative cost/benefits of sag mitigation in the dairy or the supply network it is important to know the dairy equipment immunity level. It is shown how a harmonic generator can be used to determine this information. Testing revealed that the motor contactor was a critical component as it was unable to ride through a 40% sag longer than about 0.5 seconds. The milking equipment without contactor gave unsatisfactory performance for 50% sags longer than 1 second and for interruptions exceeding 0.5 second.

6. "The application of IEC 61000-3-6 to MV systems in Australia", V.J. Gosbell, D.A. Robinson, S.P. Perera and A. Baitech, Conf. Proc. Quality and Security of Electrical Supply, Thame, UK, Feb. 2001, pp.7.2.1-7.2.10.

Abstract: IEC 61000-3-6 comprises a number of stages and tests to determine harmonic emission allowances for customers

connected to MV and HV networks. Of particular importance is the section concerning loads distributed along a feeder, each having a different fault level. Although a common situation, the treatment given in the IEC standard is poorly described, being largely illustrated by one atypical example.

This allows simplifying assumptions to be made which are invalid in practical cases. This paper outlines a more general approach that is relatively easy to apply.

International Students Assist with Flickermeter Development

Two undergraduate students from the University of Orleans, France, have recently completed seven weeks of industrial training with the Centre. The projects they were given involved further development of a PC-based flickermeter that was designed at the Centre. Voltage fluctuations can produce annoying light flicker and can adversely affect the operation of some electrical equipment. Flickermeters measure these fluctuations, perform statistical analyses and produce flicker severity indices that can be compared to standard limits.

Frederic Goutaudier worked on the hardware and software design of a calibrated voltage fluctuation source. A micro-controller system

was used to apply appropriate voltage waveforms to a light globe via an amplifier/transformer system. This was developed to allow calibration of flickermeters and to do further assessment of flicker sensitivity of individuals.

Angelique Parent implemented the PC-based flickermeter in Visual C++. The original flickermeter was developed using Microsoft Excel spreadsheets and Visual Basic macros. This system was quite slow in operation. Implementing the flickermeter in Visual C++ has greatly increased its operating speed. The eventual aim is to produce a real-time flickermeter system.

Example on Use of PSCAD/EMTDC™ Transients Simulator

The PSCAD/EMTDC™ simulation on the next page, illustrates capacitor switching transients in a power system. There are 2 banks of capacitors switched one after the other (0.25s and 0.4s) on the high voltage system (66kV). The capacitors on the 11kV system are permanently connected. The plant power factor correction capacitors can be switched in and out if desired. The simulation clearly demonstrates the transients on the 66kV system affecting the plant. If there are sensitive equipment at the plant such as

variable speed drives there is the possibility that they will trip due to dc bus overvoltage as a result of the capacitor switching transient. It is also evident that the transient due to the second bank of 66kV capacitors generates a less severe transient on the overall system.

Integral Energy Power Quality Centre has the capability to use PSCAD/EMTDC™ effectively to investigate power quality problems of this type.

