# Centre Journal

Winter 2003/04

MANITOBA·HVDC RESEARCH CENTRE



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## PSCAD Users Group Meeting

The Manitoba HVDC Research Centre is pleased to announce that we intend to sponsor a PSCAD Users Group Meeting to be held tentatively June 21st and 22th in Princeton, New Jersey. This Meeting is being coordinated by Nayak Corporation of Princeton and will include end-user simulation studies presentations, an opportunity to discuss simulation topics, and future PSCAD/EMTDC requirements with our developers and end-users. An Advanced Topics PSCAD course will also be part of the meeting. There will also be a tour of the Princeton Plasma Physics Lab at Princeton University (a longtime PSCAD User). For registration and information, please contact Dr. Om Nayak of Nayak Corp. Inc., om@nayakcorp.com, (609) 279-9050, www.nayakcorp.com.

## Flicker in a Large Reciprocating Motor Load

In the fall of 2003, The Manitoba HVDC Research Centre Inc., through its engineering services group, were contracted to perform a study for an SVC replacement project. The existing SVC, which was near the end of its life, and not operating efficiently, was being used for voltage control and flicker mitigation due to a large reciprocating motor load. This motor load totals 66,000hp between 9 machines.

There were two types of machines, one set of 6 – 8000HP compressor motors rotating at 300 rpm, and one set of 3 – 6000HP compressor motors rotating at 327.27 rpm, as shown in Figure 1. The 8000HP motors were setup into 3 groups of 2, with each group's compression cycle spread over 120 mechanical degrees on the shaft rotation. The motors were configured like this to minimize the torque pulsations, and therefore flicker.

The 6000HP motors were not configured as such, and had all 3 motors compressing at the same time. In this configuration, the only dominant flicker component should be at around 5.12 Hz, which can be easily calculated using a weighted average methodology [eqn 1]:

$$\frac{327.27rpm \cdot (3 \cdot 6000)}{6 \cdot 8000 + 3 \cdot 6000} + \frac{300rpm \cdot (6 \cdot 8000)}{66000} = 307.44rpm = 5.12Hz$$

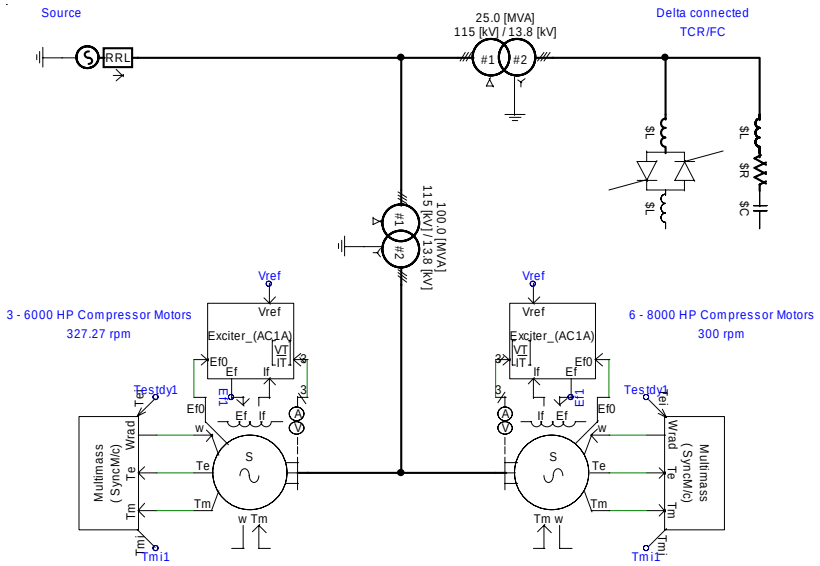


*Figure 1: Reciprocating Motor Flicker Study Diagram*

Despite these measures, in adjacent towns a fairly severe flicker problem was evident in the incandescent lighting and was easily observed in measurements taken at the station.

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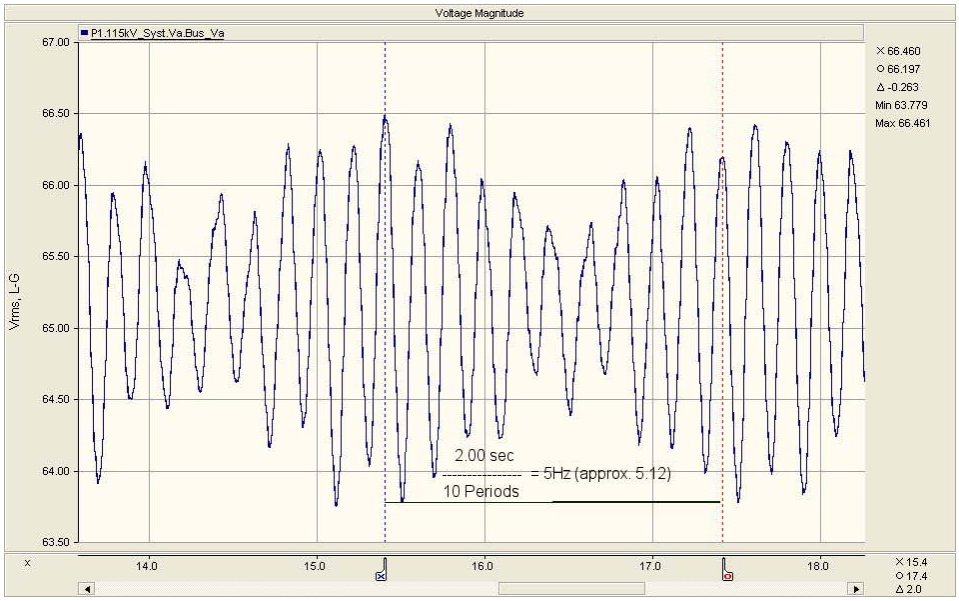


*Figure 2: 5 Hz Flicker Disturbance*

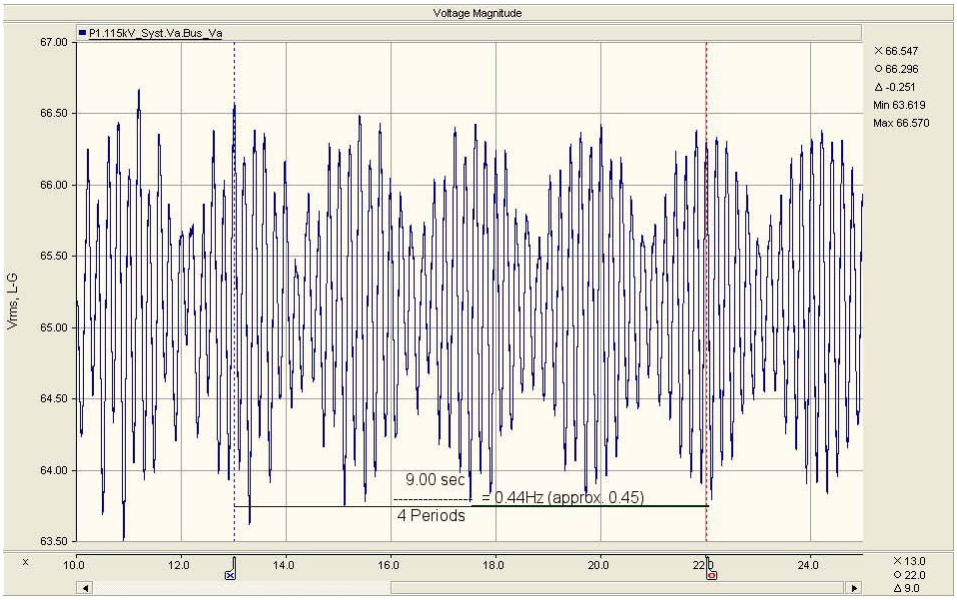


*Figure 3: 0.45 Hz Subsynchronous Flicker Distrurbance*

*Continued from page 1*

If the 8000HP motors were rotating at 300 rpm, and the 6000HP motors at 327.27 rpm and all machines on the same compression cycle, the pulsating exhibited was due to the two sets of motors creating a beat frequency at 0.4546Hz. This beat frequency can be calculated as follows [eqn 2]:

$$327.273rpm - 300rpm =$$

$$\frac{27.273rpm}{60} = 0.4546Hz$$

PSCAD simulations did reproduce this behaviour if the compression cycle of the 8000HP machines were set to be additive, and not spread out over the 120 mechanical degrees, as indicated by the motor operators. The magnitudes of the oscillations are not the same, but since actual system conditions in which the actual measurements were taken are not known, we can conclude that the results are fairly representative. The 5.12 Hz component was also present in this simulation.

These two flicker components can easily be seen in Figures 2 and 3. A resolution to this issue is still under investigation.

*By Dan Kell*
*Application Support Engineer*

## PSCAD Users' Community

To enhance our customer service and support processes, the Manitoba HVDC Research Centre is developing the PSCAD Users' Community. Registered users of our PSCAD website will be able access this community using their email address and PIN, as opposed to a user id and password. Access to downloads of available libraries, example cases, discussions forums, and the ability to share items, tips, techniques, and feedback directly with our users at large, and our development team in a central location will benefit all users.

For clients with valid maintenance contracts, the same services will be available with the addition of a new Customer Support Portal that will allow searching of solutions, priority helpdesk support service, issue report entry and tracking. Access to the downloads page will also be available.

We anticipate that the PSCAD Users' Community will be ready within the next quarter. Please visit the website for further information as it becomes available, or contact info@pscad.com

*By Paul Wilson*
*Managing Director*

## Studying Bus Transfer Transients in a Nuclear Power Plant

PSCAD/EMTDC V3 was recently used by Washington Group International for performing the fast bus transfer study on Entergy Corp.'s IPEC Energy Center Indian Point 2 (IP2). The simulation model consisted of roughly 50 induction motors both at the 6.9kV and 480 Volts level with dynamic load torques, nine (9) transformers, tap changers, bus transfer scheme, bus fault, load sequencing, more than 70 breakers, cables, and transmission lines. The top level diagram of the PSCAD case constructed from connected page components is shown below in Figure 4.

This study analyzed the IP2 electrical distribution system for a Safety Injection load sequencing event, including the motor starting transients, and fast bus transfer of the Unit Auxiliary Transformer (UAT) loads to the Station Auxiliary Transformer (SAT) with a six (6) cycle dead-bus time. A Safety Injection (SI) is the process that provides borated water to cool the reactor core in the event of a loss of coolant accident (LOCA).

The objective of this analysis was to determine the terminal voltage profiles of all the safety related motors for a given sequence of motor starting and operation during the first 58 seconds after the SI event to make sure that the motors can operate within their specified range. The study also addressed the impact of voltage variation at the 138kV Buchanan substation that feeds the SAT, initial tap positions and fault conditions.

The case was set up to study 12 cases (scenarios) with 8 parameters being set for each case. It was very

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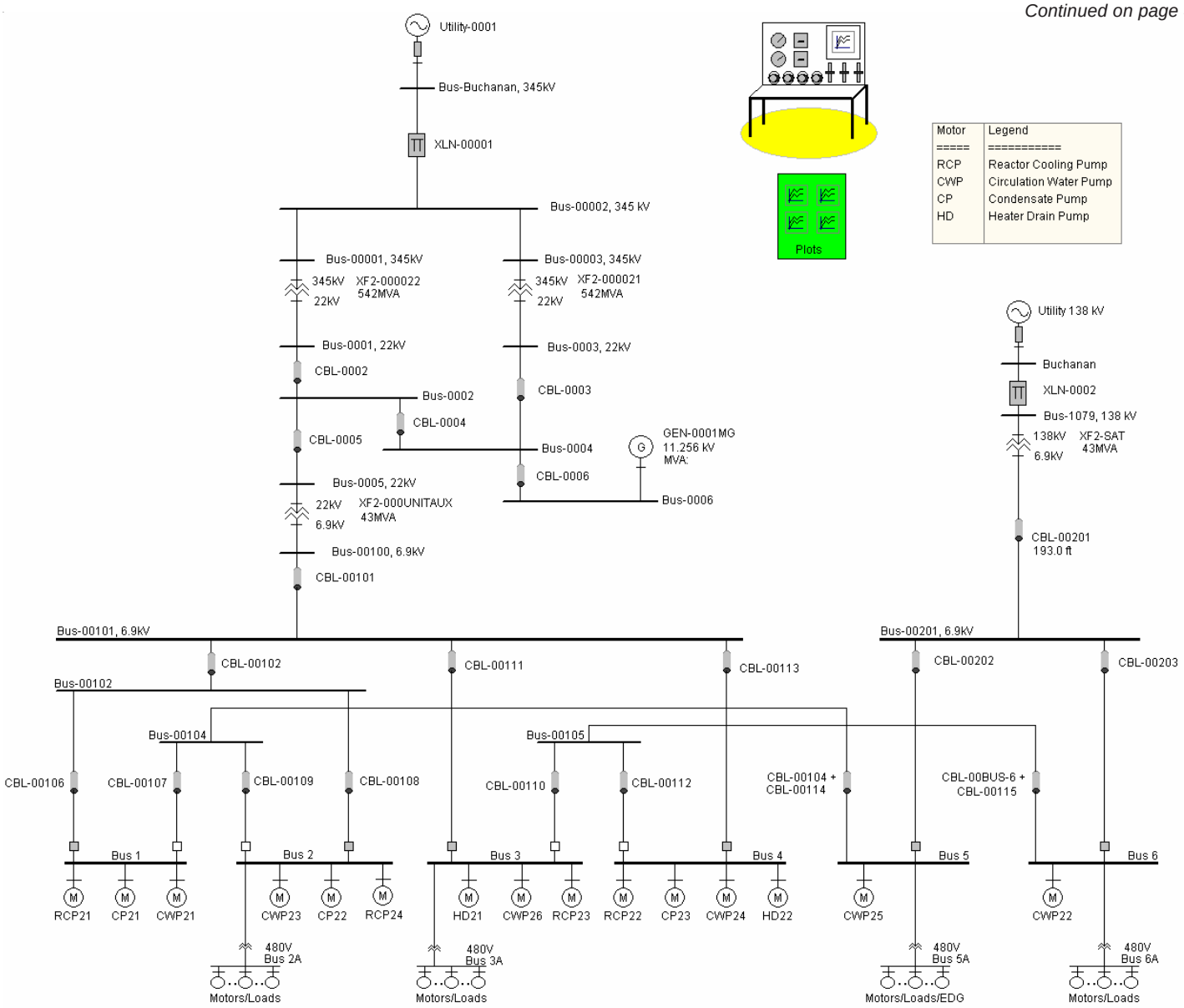



*Figure 4: Indian Point 2 Nuclear Power Plant PSCAD Circuit*

*Continued from page 3*

important to organize the case in a systematic way to minimize the potential for error in data entry and version control. The case was arranged in three hierarchical levels: top level, 6.9 kV and up, and 480 Volts. All the case parameters were set in one location in the simulation using table components which are selected by a selector switch input. See PSCAD programming blocks below in Figures 5 and 6.

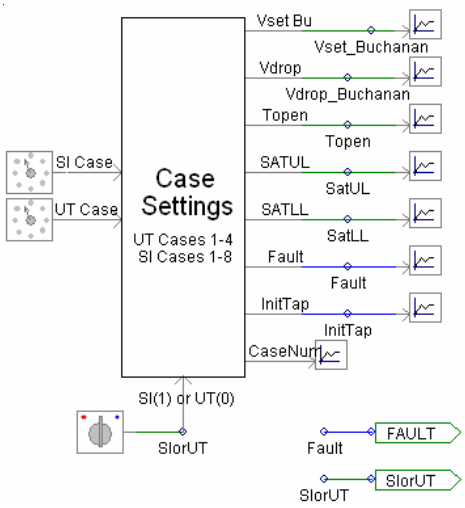



*Figure 5: Case Settings Control Interface*

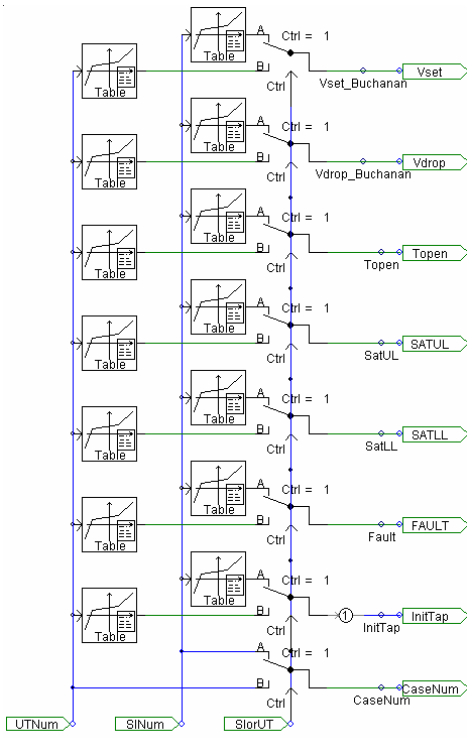



*Figure 6: Case Settings Definition*

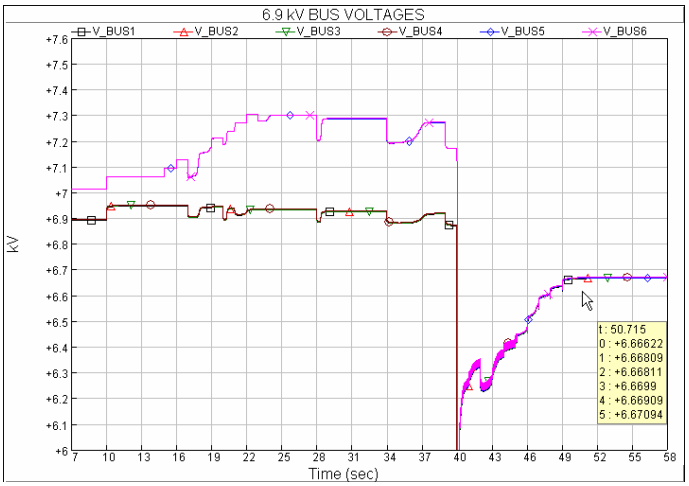



*Figure 7: 6.9 kV Bus Voltage During SI and Fast Bus Transfer*

The case parameters were passed to other modules through hidden import/export connections. Thus, any case could be simulated by simply changing the case selector switch.

Since this was a nuclear safety related study, only nuclear certified software can be used. PSCAD was verified and validated according to Software Quality Assurance (SQA) regulatory guides and Washington Group International SQA procedures prior to the study. The results of PSCAD were verified and validated against other nuclear certified analysis tools, such as a power flow and transient analysis program. Where appropriate, verification was performed using hand calculations and proofs. Samples of output are shown in Figure 7 for the 6.9kV bus, and Figure 8 for the 480Volt bus. PSCAD results matched with the validated results within 0.5% taking into consideration differences in the methods of analysis and modeling details.

The study determined successful bus transfer capability of IP2 in all cases. As a result of the successful conclusion of this study, PSCAD/EMTDC V3 is now used by Washington Group for other nuclear safety related transient studies.

*Submitted By Dr. Om Nayak*
*(Nayak Corporation)*
*and*
*Ravi Yedithi*
*(Washington Group International)*

*The Centre and the Authors would like to thank and acknowledge Joseph Raffaele, Herbert Robinson and Eric Anderson (Entergy Corp) for their important contributions.*

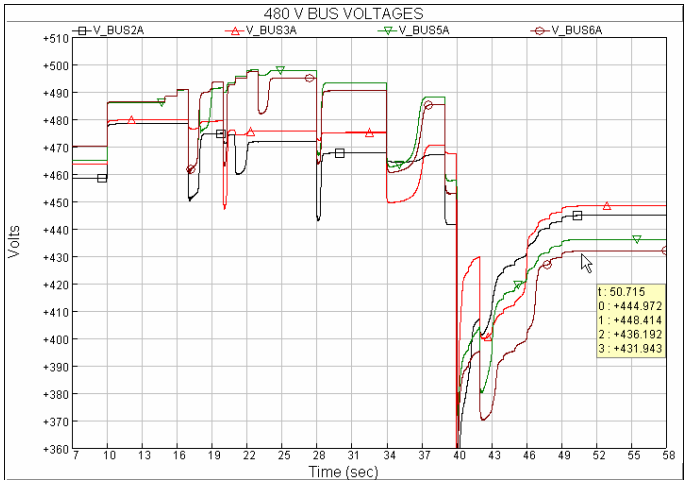
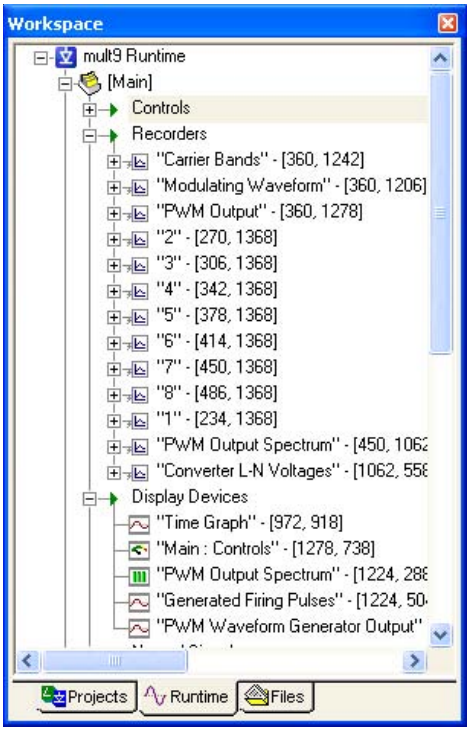



*Figure 8: 480 V Bus Voltage During SI and Fast Bus Transfer*

## PSCAD V4.1 in Beta

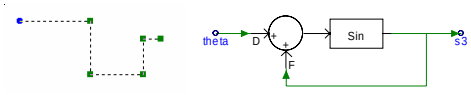
A significant amount of work has been put into Version 4 in the last year and this has resulted in a more stable and more powerful version of this very successful version. Here are some of the key items:

• **Enhanced Workspace**: New views allow you to navigate more detailed runtime information and files. Most plotting and online control display design, as well as navigational operations can now be performed directly.




• **Drag and Drop**: New Drag and Drop functionality for component instances, as well as runtime related features, such as curves and controls, can be created directly from the workspace or from the control components themselves.

• **More Powerful Wires**: Wires are now represented as a pathway rather than a simple line segment. These new and improved Wires can be manipulated as a set of segments, and may be merged or decomposed at will. In addition, it is now possible to show control signal flow on data wires. The indicators appear as small arrows, pointing in the direction of signal flow.

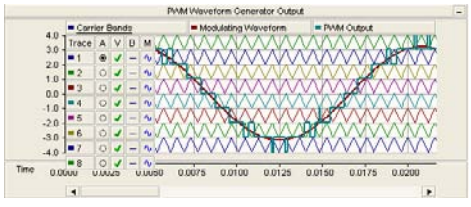



• **Wireless Control Connections**: A new component called a 'radiolink' can be used to transmit data signals from anywhere to anywhere in the project, without wires. Similar to defining a global variable, it provides a formal data transfer mechanism that is simple and effective without the need for imports and exports.

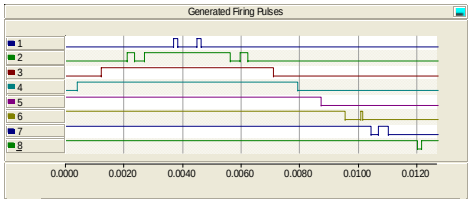

• **Control Group Names**: A popular feature in Version 2, this ability returns. Runtime objects, such as online controls and displays may now be grouped according to user defined name. A new convenient viewing dialog window has been added to provide an efficient means of viewing control template settings.

• **Array Trace Recording**: No more scalar limitations! Output channels will now directly accept arrays of both REAL and INTEGER types. This eliminates the need to tap arrays into scalars and record each one. All traces in the arrays are synchronized to a single storage device.

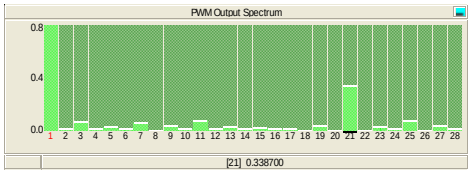
• **Multi Trace Curves**: Array recordings are supported by an enhanced curve object that will plot any and all traces of an array on a single graph. Thus, an array recorder can be plotted using a single curve object.




• **PolyGraphs**: A new stacked graph has been designed to accept the new curves and stack each trace as either a digital or analog signal.




• **PolyMeters**: This new display type can be used to view instantaneous data array magnitudes online. This is of particular convenience when viewing harmonic spectrums.



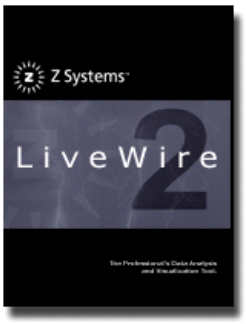

• **New Library Models**: ***Optimum Run*** takes advantage of new advancements in multiple run optimizations. It comes with several optimization methods to drastically reduce multi-runs. ***1-Phase/3-Phase RMS Meters*** have new algorithms included, which calculate the RMS value using a sliding window. This effectively removes any output ripple while retaining its dynamic properties. An ***Internal Combustion Engine*** model is now provided to act as a prime mover torque input on generators. Both 1-phase and 3-phase ***Autotransformer*** models are now provided.

I am very pleased with results of this effort. The new improvements compliment the single line capabilities introduced in V4.0 and go much further to create a powerful tool for manipulating and visualizing transients data. If you are a licensed professional user and would like to be a part of the Beta program, contact me for further information.

*Craig Muller*
*PSCAD Development Manager*

## LiveWire 2.0

The Professional's Data Analysis and Visualization Tool.




LiveWire 2.0 is an excellent replacement for the Multiplot application that is bundled with PSCAD V2. Many of the features available in Multiplot are now available in LiveWire and many more are to come. LiveWire allows multiple output EMTDC file imports, COMTRADE file import/exports, curve mathematics, workspace creation/ storage and retrieval, and multiple page documents. New items in progress are semi-log plotting, intelligent channel naming and tracking, annotations layer, component selection/alignment, and advanced DFT functions.

If you are interested in evaluating or purchasing LiveWire, please contact us at sales@pscad.com for more information. For more information on LiveWire see www.zsystems.mb.ca

A free unlicensed version of LiveWire (LiveWire Lite) is available from both the PSCAD and Z Systems websites.

*Mark Kulchycki,*
*(Z Systems, Inc.)*
*mark@zsystems.mb.ca*

## Final Notice!

The Centre will be discontinuing PSCAD V2 for the Unix and Linux platforms. This product is obsolete and is no longer being offered for sale. The Centre will continue to provide service and support for the period from September 1st, 2003 to July 31st, 2004. Any PSCAD V2 support contracts expiring in that period will not be renewed. We thank all of our customers who adopted and supported this unique and powerful product, and we are prepared to help customers who need assistance in migrating to the newer PSCAD V4 platform. Please contact upgrade@pscad.com for more information.

## The Manitoba HVDC Research Centre will be participating in the following upcoming events:

**7th International Naval Engineering Conference**
The Institute of Marine Engineering, Science and Technology: Paper on "PSCAD for the Simulation of Ship Electric Power Quality Studies" March 16-18, Amsterdam

**Transmission & Distribution World 2004**
May 25 - 27, Indianapolis, USA

**IEEE PES 2004 General Meeting**
June 6 - 10, Denver, USA

**PSCAD Users' Group Meeting (U.S.A)**
June 21 - 22, Princeton, New Jersey

**PSCAD Version 4 Training Courses**
April 20 - 23, 2004 and July 13 - 16, 2004, Winnipeg, Canada

**CIGRÉ 2004 Exposition**
August 29 - Sept. 3, Paris

**IEEE 2004 Power Systems Conference & Exposition**
October 10 - 13, 2004, Grand Hyatt Hotel, New York

**CEDRAT European Users Club 2004**
includes PSCAD Training
October 14 - 15 Grenoble, France (www.cedrat.com)

**We look forward to seeing you!**

PSCAD

## Announcing PSCAD V4.0.3

All PSCAD Version 4 users with a current maintenance contract or warranty coverage can download V4.0.3 free of charge. PSCAD V3 or V2 Users wishing to upgrade to the new Version 4, please contact us at email upgrade@pscad.com.

**Download PSCAD 4.0.3 at http://www.pscad.com**