Centre Journal

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MANITOBA·HVDC RESEARCH CENTRE

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Investigation of Anomalous Discharge on FRP–Hot Sticks

In servicing high voltage lines, it is standard practice for Manitoba Hydro's live line crews to work on energized lines using specialized equipment, such as hot sticks.

A hot stick consists of one or more sections of a fibreglass-reinforced pole. Linemen attach a variety of special tools at the far end of the stick to perform a range of tasks on energized lines from a safe operating distance.

On March 20, 2002, two Manitoba Hydro linemen experienced a hot stick flashover while working on a 500 kV line. Fortunately they were not seriously injured. One lineman received first degree burns to his right wrist. Both men were able to climb down the tower on their own. They were taken to hospital for examination and were

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Electric Arc Furnace Modeling and Validation

Modern power systems have a variety of connected nonlinear loads, the ability to study and understand power quality issues is becoming more important. It is necessary to understand the sources of power disturbances and equally imperative to determine practical means to mitigate these power quality problems.

A major contributer to power quality issues, specifically voltage flicker, is the Electric Arc Furnace. The electric simulation.

The new PSCAD electric arc furnace model was studied as a part of the electrical network as depicted in Figure 1. The voltage-current characteristic of an electric arc furnace is depicted in Figure 2. In a simulated attempt to reduce voltage flicker, the size of the STATCOM in the network was varied, while the size of the capacitors and parameters of the arc furnace remained fixed. The power of

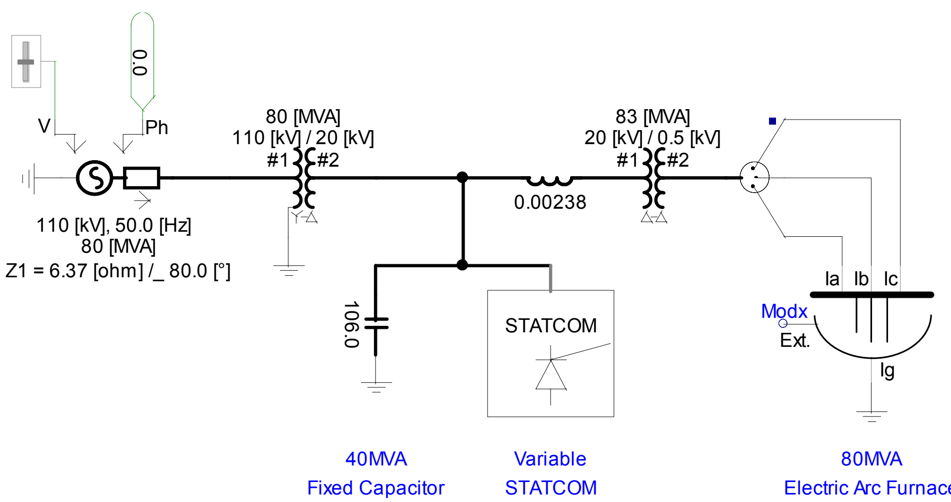

Figure 1: PSCAD Electric Arc Furnace System

arc furnace is a highly variable non-linear load, which according to some studies, possesses what is described as a chaotic pattern.

In response to high client interest, the Manitoba HVDC Research Centre has begun development of an Electric Arc Furnace model. The arc furnace model employs non-linear differential equations[1] as opposed to the traditional piece-wise linear method resulting in more accurate and realistic the new arc furnace model within the PSCAD environment became apparent when a selection of different sized STATCOMs were evaluated in the model. PSCAD was also able to simulate the UIE Flickermeter to "block 4" which means an instantaneous value of flicker is generated. When averaged over the length of the simulation run, Block 4 gives an indication of the level of voltage flicker

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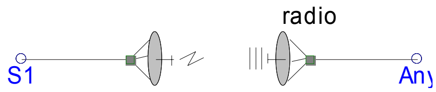
A Glimpse of PSCAD V4.1

PSCAD V4.1 will include many new and exciting features. Some of the items users can expect will include:

- Wireless control signal channels to allow communication of many signals across modules.



- Drag and drop of components, controls, and plot channels from the project tree to the drawing canvas.
- More power and flexibility in project window pane with channel and file reference tabs
- Poly curves that will allow multiple channels to be recorded with one output channel component. Thus if a three (or n) phase channel is recorded, it is a simple matter to plot all channels to one plot with one simple key stroke.
- The creation of a new poly meter component that will allow multiple channel data to be displayed in a simple and user friendly bar display, ideal for online output from the FFT block.
- New models with the addition of a single phase motor model and switched reluctance machine model.

Due to time contraints we were unable to include the much requested Power Flow in this version of PSCAD. We are revising our release plans and at this time we anticipate that Power Flow will be released in PSCAD version 5. We still need to determine from our client base if this is the right course of action and will be working with several clients for their feedback.

by Paul Wilson

Important Notice

The Centre has decided to discontinue PSCAD V2 for the Unix and Linux platforms. This product is obsolete and will no longer be 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 Human Factor in Simulation Software Development

"Facts do not cease to exist because they are ignored" - Aldous Huxley

It has been through the development of the new PSCAD Version 4 simulation software that the development team has faced the human side of engineering. We, of course, anticipate that PSCAD Version 4 will be well-accepted by our worldwide user base, but it has been a struggle to design new functions and improve methods in part due to our own human tendency to believe in a truth.

I had the opportunity to attend a talk at the University of Manitoba by Dr. Henry Petroski, Professor of Engineering at Duke University, North Carolina. Dr. Petroski writes about the engineering profession. He has a common sense approach to the everyday activities in the engineering field. It was while listening to Dr. Petroski that I realized that what myself and others had encountered during the development of the new PSCAD Version 4 was something not unique to software development, but in fact, to the engineering practice in general. As Dr. Petroski was summing up his talk, he made a very simple statement that underscored the general pattern laid out before us. He said "Ultimately, all success leads to failure, just as failure leads to success." I pondered these words for some time, feeling that somehow this applies to the world of software development, as well. The fact that failure leads to success was obvious. But how did the reverse apply? What was the common strain that worked its way through to create that which is less successful than before? I realized that the root cause for the failure was a human characteristic of belief in a truth. When a design is created, it seems that we are willing to give it a try. If it succeeds, then it gains more "truthfulness" and continues to get more credit as it repeats its success. At some point however, an assumption takes over and we believe the design to be "absolutely" truthful, giving it the spectre of infallibility. The design is then pushed beyond its constraints, without consideration, and ultimately to collapse.

When the "correctness assumption" manifests itself in software, it can be a trying experience. With simulators such a PSCAD, everything is an approximation, otherwise it would not be a simulation, and it would be reality. Nevertheless, when trying to improve on the solution, it is not uncommon to hear the statement "I compared the results from the new version to the results of the old version and they differ. The new version must be wrong." This becomes the struggle. How do you create something different and better while keeping enough of it the same to satisfy those who believe in the old design?

I always felt the software itself contained the toughest challenges, the trickiest design requirements. Through the past 15 years of my career, the push was to develop skills that could overcome these problems and bring the software to a new level. It seems that the biggest hurdle we face in software design is a human factor, and cannot be expressed in any programming language! This makes the dynamic of engineering creation just a bit more challenging.

by Craig Muller

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occuring on the bus. Normally this "instantaneous flicker" is collected and scaled over 10 minutes to provide a Pst value[2]. By first running the simulation without compensation, we get a benchmark upon which to compare the compensated results. And, we are able to quite easily calculate the percent flicker reduction achieved by the various runs. Referring to Figure 3, we can determine the most economical size of STATCOM that would be needed to reduce the voltage flicker to an acceptable level.

In a continued effort to provide realistic and accurate validated models to end-users, the Centre welcomes interested parties to participate in the development of the arc furnace model by providing us with actual recorded data from industrial arc furnace installations, or any other information that may be of interest. If you wish to participate, please contact Dan Kell at dkell@hvdc.ca.

By Dan Kell

[1] E.Acha, A. Semlyen, and N. Rajakovic, "A Harmonic Domain Computational Package for Nonlinear Problems and its Application to Electric Arcs," IEEE Transactions on Power Delivery, vol. 5, no. 3, pp 1390-1395, July 1990

[2] J. Wikston, "The UIE/IEC Flickermeter Description," IEEE PES, Tutorial on Voltage Fluctuations and Lamp Flicker in Electric Power Systems, pp. 11, Feb. 2001

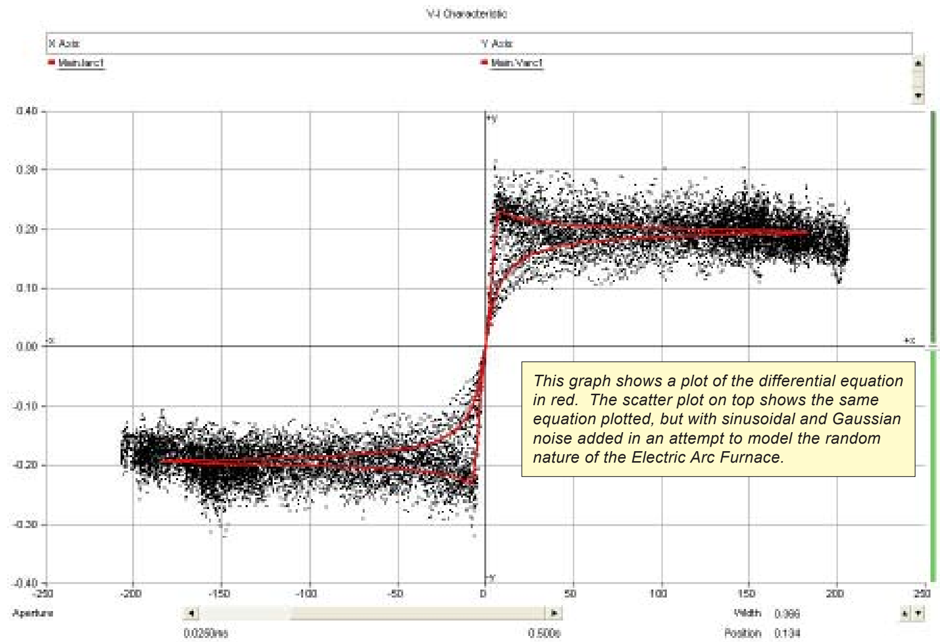

Figure 2: V-I Characteristic of an Electric Arc (including reference plot and scatter, using the advanced plotting capabilities of the Livewire 2)

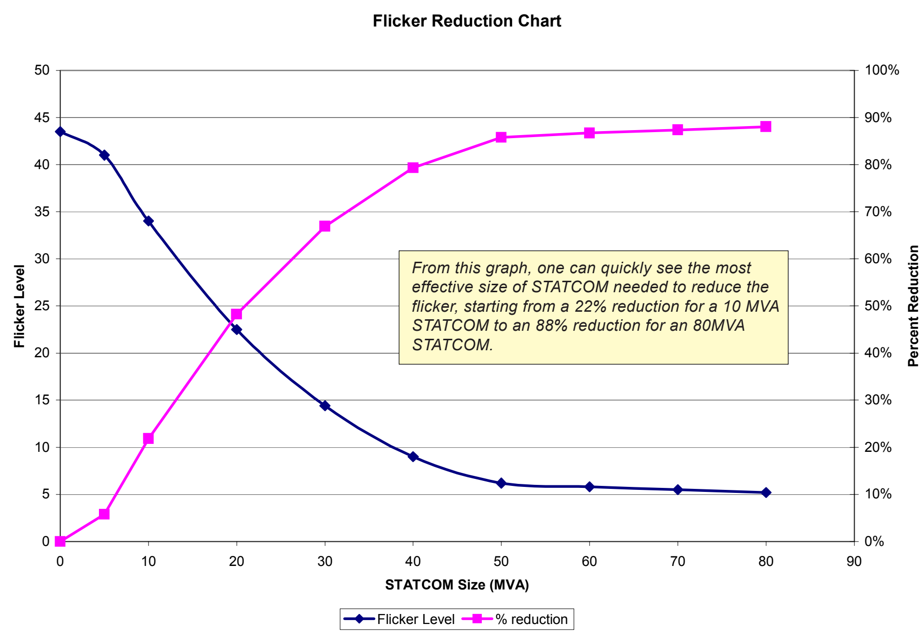

Figure 3: Flicker Reduction

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released the same day.

The following day, live line work, using hot sticks from steel or wood structures at 66 kV or higher voltages, was suspended. Work will not resume until the type of flashover they experienced is understood and action is taken to meet Manitoba Hydro safety standards.

An incident investigation team is working to analyse the incident and gain a better understanding of flashovers.

Researchers at the Manitoba HVDC Research Centre were commissioned to perform testing in cooperation with Manitoba Hydro. A meter for measuring static charge was mounted on a platform that allowed the meter to move the length of the hot stick.

The meter used was developed by NASA's Jet Propulsion Laboratory. During the early years of the shuttle program, it measured charge within the clouds before launching. If charge magnitudes were above acceptable levels, launching was either delayed or cancelled.

The Manitoba HVDC Research Centre measured static charge along the hot stick in varying conditions, such as humidity when exposed to varying ac corona. Various methods of

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cleaning, waxing, and handling the sticks were also evaluated.

Results showed that when a hot stick is handled, as in typical fieldwork, a static charge of more than 150,000 volts/metre can build up on the stick. Such a charge is capable of raising body hairs if you are standing within a metre of the stick.

To date, there is no conclusive evidence for static charge as the explanation of the flashover at Manitoba Hydro. Research work is expected to continue, to better understand the triggering mechanism that causes the flashovers. Additional investigations will include:

- analysis of Manitoba Hydro's system performance at the time of the incident.
- re-enactment of the incident on the tower during a planned outage.
- building a duplicate tower window, which will be energized at line voltage for controlled live line tests.

by Norm Tarko

RTP V3 Released!

Connect to RTP over your network.

The Real Time Playback system has been enchanced to provide better performance and features. The RTP V3 system compliments PSCAD V4 and any waveform generated in

PSCAD (with 35 micro-second timestep or greater) can be played out in real time to provide full frequency transient testing of ac protection and control systems.

The Version 3 of RTP consists of an intelligent RTP server installed as a 6U 19-inch rack mountable system. The RTP server is controlled and connected to the RTP Client software with a computer network or directly between a PC both using the Ethernet TCP/IP protocol. Data transfer is extremely fast easily handling long playback files.

The RTP Client software resides on any PC with a Windows based operating system (98, NT, 2000 or XP) and a network connection. The RTP graphical user interface software provides an easy-to-use and intuitive interface.

To see the capabilities of the RTP, the RTP Client software can be downloaded from our website at http://www.pscad.com

by Randy Wachal

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

IEEE/PES Summer Meeting
Hospitality Suite, July 14, Sheraton Centre Toronto, Suite 3629

IEEE/PES T&D Conference
Sept. 7-12, Booth 4035, Dallas, Texas

PSCAD Version 4 Training
Sept. 23-25, Winnipeg, Canada (www.pscad.com/service)

International Power Systems Transients Conference
Sept. 28 - Oct. 2, New Orleans

European Flux Users Group
Oct. 23-24, Paris, France

PSCAD Transient Simulation for Power Quality Analysis
PAC14, November 2 • Power Quality 2003, Long Beach, CA

We look forward to seeing you!

PSCAD

Announcing PSCAD V4.0.2

All PSCAD Version 4 users with a current maintenance contract or warranty coverage can download V4.0.2 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 4.0.2 at http://www.pscad.com