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Prediction of AC Induced Voltage on De-energized Transmission Lines

When a utility performs transmission line construction, maintenance or salvage, employee safety is an important concern. One of the questions that is consistently asked is the effect of electromagnetic induction from any nearby energized circuits. PSCAD can be used to model and predict the induced voltage on a line section from nearby lines. Comparison of PSCAD simulation results with field measurements increases the confidence in the prediction of potential safety hazards resulting from induced voltages.

In the spring of 2000 an 18.6 km section of 230 kV transmission line was being re-conducted by Manitoba Hydro to allow for increased power transfer. The line section was in the same right of way as two twin circuit 230 kV transmission lines that would remain energized during the work.

The line geometry is illustrated in Figure 1.

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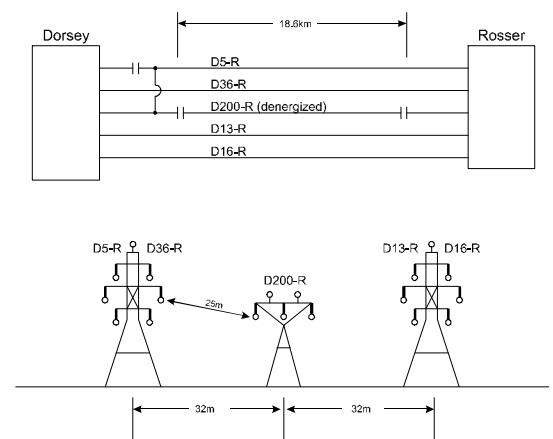


Figure 1: System Configuration

Our New Centre

On April 17th we proudly moved in to our new Manitoba HVDC Research Centre. It is a beautiful modern facility complete with state-of-the-art labs, classroom facilities, and room to grow. A lot of hard work and planning by



Dick Hunter, combined with the support and enthusiasm of all staff, made this a very successful move. We will be hosting PSCAD User training sessions in our new facility throughout the year and extend an open invitation to all our customers and partners to pay us a visit.

We are pleased to say that there are a number of exciting research and product development projects moving forward at the Centre. We have been collaborating with industry in new development initiatives. A good example of this is our PSCAD/Relay simulation program when combined with a protection relay test set provides an accurate and straightforward test environment. Protection engineers and technologists will be able to test the complete operation of the protection system and eliminate nuisance trips and forced outages.

Our Centre has gained a reputation as a reliable and innovative developer of power systems simulation technology. This now results in emerging opportunities that will keep the Centre vibrant and growing. We thank you for your support and hope to see you soon. ☒



A Glimpse at PSCAD Version 4



The development of Version 4 of PSCAD is now well underway. PSCAD/EMTDC V2 and V3 Users will be able to run their existing models on the new Version 4 and benefit from significant functional enhancements. Recent developments in software technology are bringing a new look and feel to PSCAD. Some of the enhancements to anticipate are the support of single-line diagrams with n-phase representation, a brand new plotting facility, a new load flow subsystem, and frequency analysis.

PSCAD will now support full single line representations of systems, including transmission lines. This greatly simplifies the drawing requirements of a system and allows the user to represent a system in the same way it is drawn on paper. In addition, PSCAD will have advanced charting libraries integrated directly into the PSCAD runtime environment. This will provide users of PSCAD with powerful new graphical displays including X-Y and Digital trace plots. Some of the unique capabilities of these plots include a high speed rendering engine,

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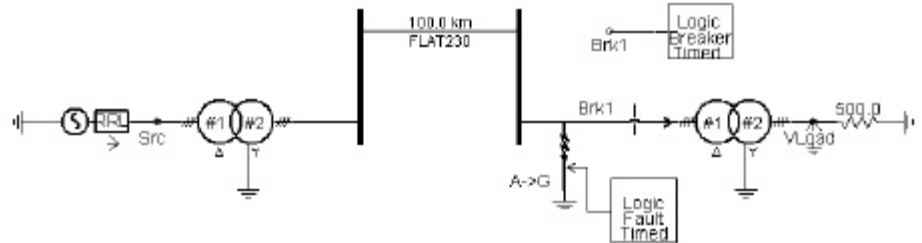


Figure 1: Single-Line Diagram Representation

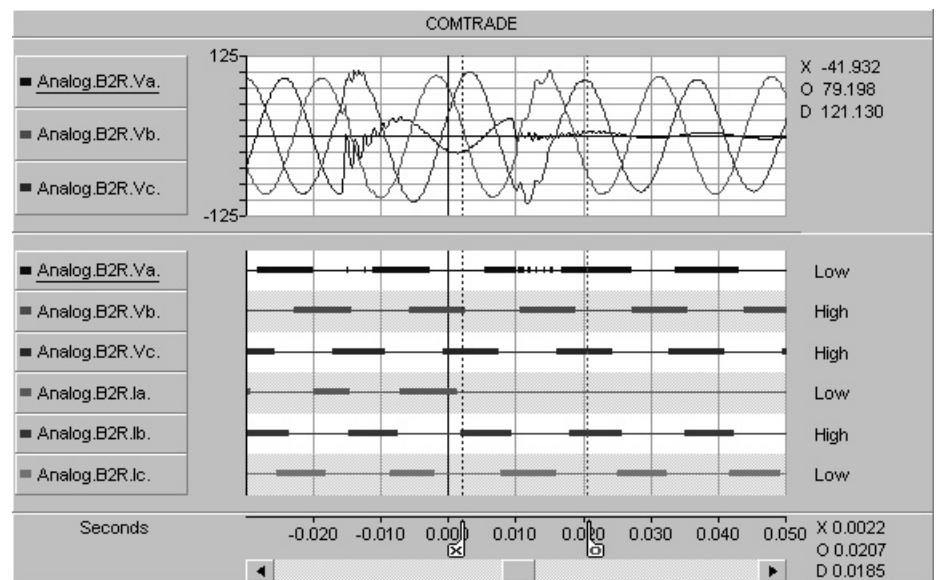


Figure 2: Analogue and Digital trace plots

PSCAD Training



PSCAD V3 Course at Enron Wind Energy, Tehachapi, California, April 2-4, 2001

Back row from left: Tom Wilkins and Mark West of Enron, Front row: Paul Buchanan, HVDC Centre, Om Nayak, Nayak Corp.

A great way to get familiar with the PSCAD Power System simulation application is to take a course. The Centre provides training to both new and advanced users of PSCAD. We can also provide custom model development services.

Our first PSCAD training course in our new classroom occurred June 13-15. The team of John Nordstrom and Dr. Rohitha Jayasinghe were the course instructors. The course attendees from the furthest afield

were Hanmin Lee and Dr. Kwang-Hae Oh of the Korean Railroad Research Institute. The next PSCAD training course will run August 13-15th at the Centre. We will also host an Advanced Users course this fall.

If you would prefer an onsite course or seminar, please let us know. In the past few months, we have conducted an advanced topics course in Finland (PSCAD Nordic Users Group), as well as onsite courses at Enron Wind (California), and Lakeland Electric (Florida). ☒

The PT was mounted at the top of this pole and protected with a fuse and lightning arrester.

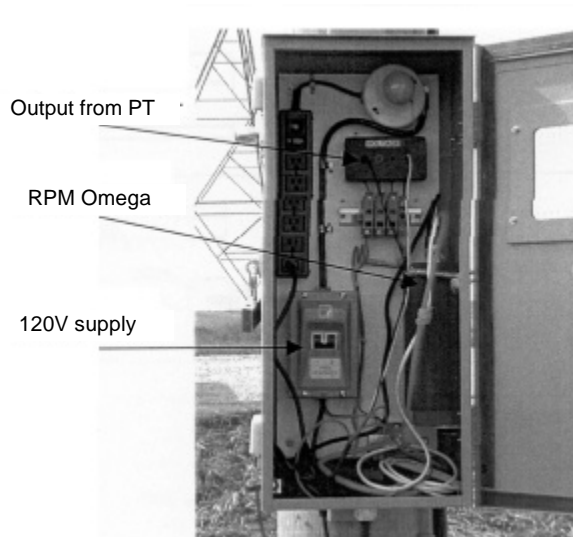


Figure 2: Field Measurement Equipment

Glenn Paskaruk has worked in the Service Quality section of Manitoba Hydro's Distribution Planning & Design Division for the past three years. His responsibilities include distribution system power quality, harmonic analysis and AC induction. Glenn has applied the Manitoba HVDC Centre's PSCAD software to a number of power quality application studies including livestock tingle voltage studies, harmonic resonance, and transformer connection analysis.



(Continued from page 1)

Field measurements of the induced voltage were taken over a three week period at a location 5 km from one end of the line. This location was chosen because a 12 kV distribution feed intersects the right of way at this location and would provide a 120 Vac source for powering the monitoring equipment. The monitoring equipment included a 15 kVA, 12kV: 120 V distribution transformer, an Artech 500VA, 14.4kV/120 V potential transformer, RPM Omega power quality analyzer, lightning arrester and interface cabinet (see Figure 2). The 15 conductor line sections were modeled using the frequency dependent phase model of PSCAD to represent the induced voltage on the line to be worked on (Figure 3). Line loadings of 600 amps rms for the four 230 kV energized circuits were obtained from the Manitoba Hydro Distribution SCADA database and represented historical nominal 60 Hz loading.

A series of simulation cases were performed, including induced open circuit voltage, induced voltage when one end of the work zone was grounded, circulating current when both ends of the work zone were grounded, as well as a number of switching fault cases (Table 1).

Comparison of field and simulation results confirmed the accuracy of the simulation, demonstrating its usefulness in predicting the overall levels of induced voltage and current onto de-energized transmission lines. This project reinforces the importance of following existing safety procedures and work methods when stringing or salvaging conductors near energized circuits. ☒

By Glenn Paskaruk, P.Eng.

Table 1: Tests	PSCAD Results	Field Measurement
Open Circuit Voltage (both ends open)	2100 Vrms	1780 Vrms
Open Circuit Voltage (one end grounded @ 10 ohms)	116 Vrms	
Circulating Current (both ends grounded @ 10 ohms)	43 Vrms 4.5 amps	67 Vrms 6.1 amps

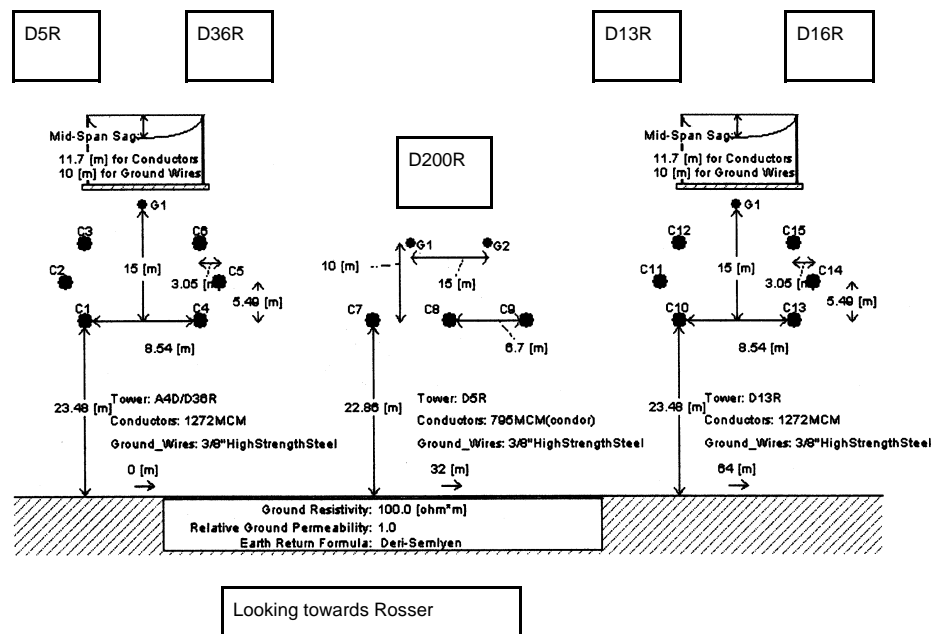


Figure 3: PSCAD Transmission Line Data

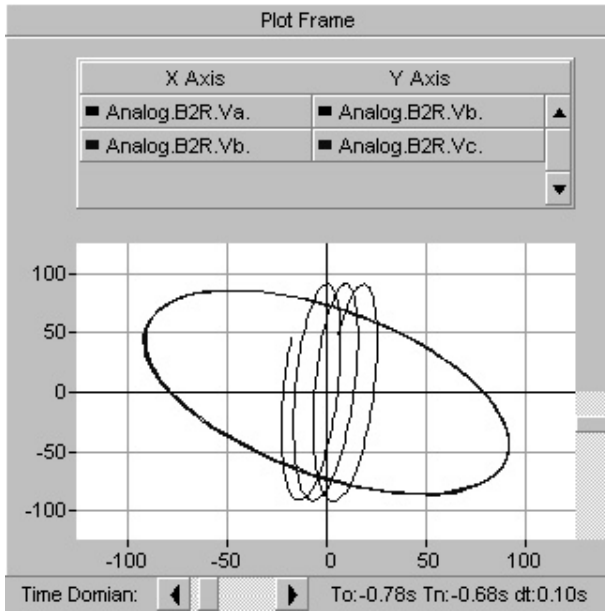


Figure 3: Time dependent X-Y Plots

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no flicker display, and dynamic axis scrolling capabilities. The Centre has partnered with Z Systems (www.zsystems.ca) to provide this mature and advanced plotting technology to PSCAD.

PSCAD load flow will facilitate all types of load flow studies, as well as provide initialization to a number of emerging PSCAD application modules. For our international customers, a planned multi-language interface will allow for interactive dialogs in multiple languages.

On a final note, the Centre is releasing a protection relay testing application called PSCAD/Relay. This will be of interest to protection engineers and technologists. ☒

By Craig Muller, PSCAD Development Manager

4TH INTERNATIONAL HVDC TRANSMISSION OPERATING CONFERENCE

In Yichang, China September 6 - 8, 2001

Hosted by
State Power Corporation of China
and
Manitoba HVDC Research Centre (Canada)

The 4th International HVDC Transmission Operating Conference will immediately follow the CIGRE Symposium scheduled in nearby Wuhan September 3 to 5th, 2001. At the completion of the joint field trip to the Three Gorges site on September 6th, there will be opportunity to stay in Yichang and participate in the Operating Conference sessions September 7 to 8th. In order to register, submit a paper or find more information visit:

<http://www.hvdc.ca/OpConf>

IEEE/PES Summer Power Meeting Vancouver, Canada, July 15 – 19

The Manitoba HVDC Research Centre will be hosting a hospitality suite at the Hotel Vancouver each evening of the conference.

We look forward to seeing you!



Announcing PSCAD Release 3.0.7

The PSCAD Development Team has released an updated and improved version of PSCAD and EMTDC.

PSCAD Version 3.0.7 will provide increased performance and stability, and fix bugs reported by our user community. All PSCAD Version 3 users with a current maintenance contract can download V3.0.7 free of charge, or contact pscad@hvdc.ca to have a new CD mailed to you.

Download PSCAD 3.0.7
at
<http://www.hvdc.ca>

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