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MiPower™
Empowering Power System Engineers
Power Transmission and Distribution System Analysis Software Suite

Quarterly Newsletter

PRDC NEWS

July - September, 2011

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Inaugural Issue

Inside This Issue

Editorial Board

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From MD's Desk

Dear Reader,

It gives me immense happiness and satisfaction to share with you the launch of the PRDC newsletter. I hope this quarterly newsletter being launched will bring the PRDC colleagues, its clients, well wishers and friends to a common platform to share the accomplishments in the field of power engineering. Since inception in 1994, PRDC has excelled itself in the field of power engineering through consulting assignments, software development, embedded solutions, education and training.

My sincere thanks and gratitude to our patrons, clients, ex-employees and colleagues to make this journey a success.

The power sector in India is growing in many folds in all the three fronts, generation, transmission and distribution. Even though the capacity addition being planned in the 11th and the 12th plans has got a boost due to IPPs, the problems associated with land acquisition, allocation of coal blocks, high capital cost and interest rates may become bottlenecks in achieving these targets.

The major challenges to the transmission utilities are planning of the infrastructure requirement at right time and right place to transmit the generation to load centers. The fund starved State utilities are slowly un-bundling and new lines and substations are being built through PPP, BOOT, BOO and JV models. Right Of Way (ROW) being the major issue in the development of new transmission corridors, it is worthwhile to look into increasing the loading on the existing transmission lines through intelligent monitoring and application of FACTS devices. PRDC has extended its services to many of the transmission utilities in India and abroad in their planning exercises.

The proactive steps taken up by the Ministry of Power through Power Finance Corporation to improve the distribution sector in India is really commendable. The fund allocation to the tune of INR 10,000 crores for the IT enabled services and additional INR 40,000 crores for the distribution infrastructure developments has hopes to bring down the AT&C losses to less than 15% in major cities and towns across India. Even though most of the IT-infrastructure will be in place, data centers will be ready, the quality of the data that goes into the system in terms of GIS, network modeling, consumer indexing, billing information mapping etc., is more important rather than the quantity of data to reduce and quantify the losses accurately.

The estimation of time frame to put together the GIS data in the meaningful form might have been too optimistic with the available skilled manpower, ground realties and difficulties in collecting the data.

The success stories from pilot projects will definitely be encouraging; however the migration to all towns and cities may take some more time due to want of quality data. PRDC is supplying the network analysis module integrated with the GIS to most of the utilities under RAPDRP programme. With its vast experience in the distribution system planning studies, PRDC is well placed in providing technical consulting services to successfully implement the PART-B program – network infrastructure planning of RAPDRP initiatives.

PRDC is happy to announce the induction of about 40 young graduate and post graduate trainee engineers to its fold in the last two months. I welcome them to PRDC family. I do hope that the academic skill sets that they have acquired during their college days coupled with the practical orientation program being undertaken now will mould them into qualified engineers in the power engineering field.

PRDC has also identified few young engineers at the 3rd and 4th semesters of engineering throughout the country and has designated them as **"PRDC-EEE Students"**. I thank all the academic institutes' management in helping us to identify these budding engineers in the early stages of the electrical engineering course.

Festive season being around, I wish all the readers, their family and friends season's greeting and Happy Dasara and Diwali celebrations.

Dr. R. Nagaraja
Managing Director

Achievements

Wind Power Evacuation Studies for Rajasthan State

In recent years, wind generation is growing rapidly and wind farms are growing in size and complexity. In order to integrate large amounts of wind power successfully, a number of issues need to be addressed, including design and operation of the power system, grid infrastructure issues and grid connection of wind power. To harness the potential wind energy and integrate the same into the grid, power evacuation studies form the basic and important component of the analysis.

PRDC has carried out many studies for grid integration of wind power in all the key States in the country ranging from Tamil Nadu in southern region to Rajasthan in northern region. One such study was carried out recently for one of the leading wind turbine manufacturers who have developed more than 400MW of wind power in the Jaisalmer region of Rajasthan. The study is aimed to examine the transmission system capability in the same region for the future wind generation expansion of the order of 2000 MW. Evacuation studies have been carried out considering the solar power also, which is the other renewable source of generation getting commissioned in the region during study period. Further to investigate the effects the wind farms on the grid, the first level analysis would be to analyze the system under steady. For this purpose, load flow studies have been carried out by considering lumped representation of the wind warm generators at the pooling substation and a detailed modeling of the rest of Rajasthan power system up to 132kV transmission.

The key factors considered in the load flow analysis were:

Evacuation study scenarios

Load flow studies were performed for two wind generation scenarios which are as under, for both minimum and maximum system demand conditions:

- peak wind scenario – to develop a reliable wind power evacuation system.
- off-peak wind scenario – to examine whether bus-voltages are within limits and to suggest measures to keep the voltages within acceptable limits.

While carrying out the power flow studies for peak wind and off-peak wind seasons in a year, corresponding solar power and conventional power generations during these periods were also considered.

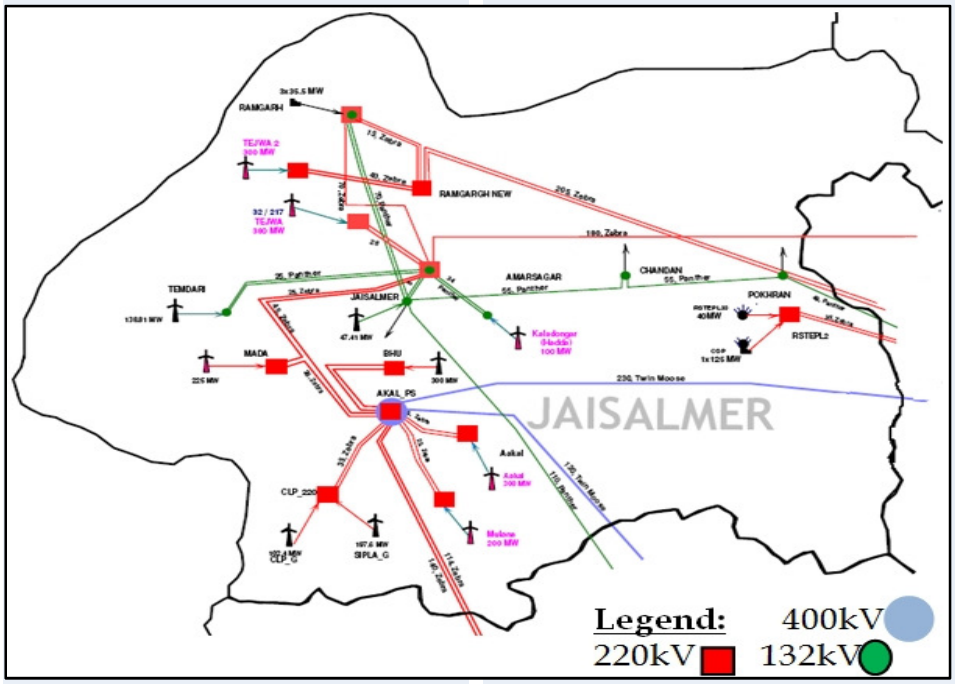
Wind farm capacity factors for grid integration studies

Capacity factor for the wind generation is the key consideration for grid integration studies. Based on available data and field experience, the consultants have derived the following capacity factors depending on the size of the wind farms and considered in the analysis-

- 100% for small wind farms (<40MW and connected at 33kV and at 66kV level);
- 90% for medium wind farms (40-100MW and connected to grid at 66 & 110/132 kV);
- 85% for large wind farms (100MW-200MW and connected to grid at 132kV, 220 kV);
- 80% for very large wind farms (>200MW and connected to grid at 220 kV and above)
- 60% to 75% for the entire State depending on the capacity connected and wind farm distribution factor.

Transmission line loadability

Another critical consideration in the study is the transmission system loadability. Generally, transmission line ampacity calculations are based on the IEEE std 738-1993 considering wind velocities of 0.5 m/s. However, in this study it was observed that the minimum cut-in speed for wind turbines are greater than 3 to 3.5 m/s. Considering 1 m/s or 1.5 m/s wind speed an increased ampacity of 20-30 % is possible in peak wind season. This can be considered safely while deciding loading of transmission lines particularly in contingency conditions which are not frequent to avoid additional investments for enhancing evacuation reliability. However, due attention needs to be paid for controlling reactive power requirement with additional compensation which has also been addressed in the study.



Technical Article

Surge Transfer Study for Power Transformer Using EMTDC/PSCAD

Veerabrahmam Bathini & Chandra Shekhar Reddy Atla

The most common primary distribution voltage in industrial systems is 13.8/11 kV. However, for large power demands, the utility system voltage may be as high as 380/400 kV. The surge transfer through the transformers depends upon the voltage turn ratio, as well as electrostatic and electromagnetic couplings of the windings. The lightning and steep fronted waves are partially transferred through the electromagnetic coupling, which is the mechanism that governs the transformer operation at power frequencies and depends upon the turn's ratio. The magnitude of these surges transferred through electromagnetic coupling is far less than the magnitude of surges transferred through electrostatic coupling hence electrostatic effects dominate the coupling of transients from the primary to the secondary windings. For slower switching surges, the electromagnetic coupling effect predominates.

The overvoltages caused by transfer of lightning and steep fronted waves or switching surges are compared with BIL of the equipments on low voltage side. In case the magnitude of transferred overvoltages exceed the BIL levels, mitigation techniques like provision of properly rated surge arresters (SA), surge capacitors etc., have to be employed to control these overvoltages. This paper concentrates on mitigation technique provided by surge arrester.

The selection of an appropriate surge arrester is an important consideration. System overvoltages under normal and faulted conditions, system grounding and ground fault clearance times should be considered in selecting a surge arrester. The selection procedure is as follows.

- Arrester rated voltage (*Vn*): selected based on maximum temporary overvoltages (*TOV*) appearing in the power network, considering earth fault factor.
- Maximum continuous operating voltage (*MCOV*): selected based on the maximum system steady state operating voltage.
- Energy Capability: selected based on switching and lightning overvoltage studies.

This article presents the modeling aspects of autotransformer and frequency dependent surge arrester for fast transients to conduct surge transfer studies for 502 MVA, 380/132/13.8 kV autotransformer using EMTDC/PSCAD. Surge arresters are usually provided on the high voltage side and low voltage side of the autotransformers. The purpose of the present paper is to analyze the surges transferred towards tertiary of autotransformer. If these surges are to be controlled to safe levels it may be necessary to provide the surge arresters at tertiary side also. Considering a worst case scenario for simulation, the lightning impulse or switching impulse injected currents at high voltage (HV) and low voltage (LV) terminals of the autotransformer are selected based on the V-I characteristics of corresponding surge arresters. The modeling methodologies, data considered for case study and simulation results are presented.

Frequency Dependent Surge Arrester Modeling

Surge arrester dynamic characteristics are significant for studies involving lightning and other fast transient surges. The time to crest for surges used in lightning studies can range from 0.5 μs to several µs. One approach for an arrester model for lightning studies would be to use a simple non-linear *V-I* characteristics based on 0.5 μs discharge voltage. This would give conservative results (higher voltages) for surges with slower time to crest. The frequency dependent model will give good results for current surges with times to crest from 0.5 μs to 40 μs. The surge arrester model proposed by Pinceti derived from *IEEE* model is used in the present paper for performing surge transfer study. The surge arrester model is presented in Fig 1.

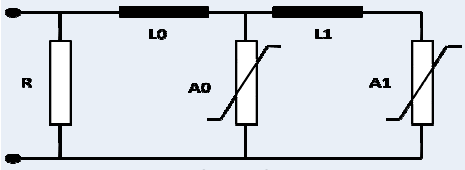


Fig 1: Frequency dependent surge arrester model proposed by Pinceti.

This model is composed by two sections of non-linear resistance usually designated by *A0* and *A1* which are separated by inductance *L1* and *L0*. The resistance *R* (about 1 *MΩ*) is added to avoid the numerical problems. The computation procedure is described in flow chart shown in Fig. 2. *Vn* is arrester rated voltage (*kV*), $V_{r8/20}$ is the residual voltage (*kV*) for the discharge current of 10 *kA*, 8/20 μs impulse, $V_{r1/T2}$ is the residual voltage (*kV*) for the discharge current 10 *kA*, *1/T2* µs steep front impulse. The fall time *T2* can vary between 2 and 20 μs. The nonlinear

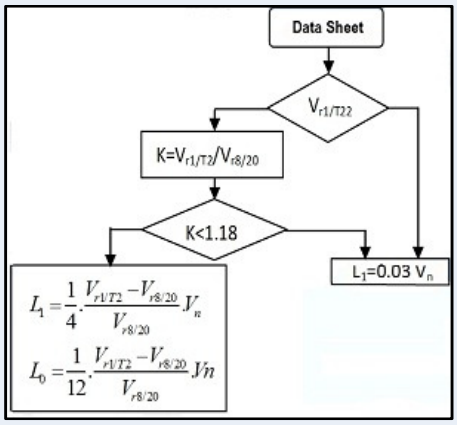


Fig 2: Flowchart to calculate elements L0 and L1

resistors A0 and A1 can be modeled as a piecewise linear V-I curves. V-I characteristic of A1 arrester is selected from manufacturer data sheet and V-I characteristic of A0 is selected based on curves proposed by IEEE W.G.3.4.11 which are shown in Fig. 3.

The V-I characteristic of A0 and value of L1 in the model have to be properly adjusted to match the manufacturer's data with respect to switching and lighting characteristics.

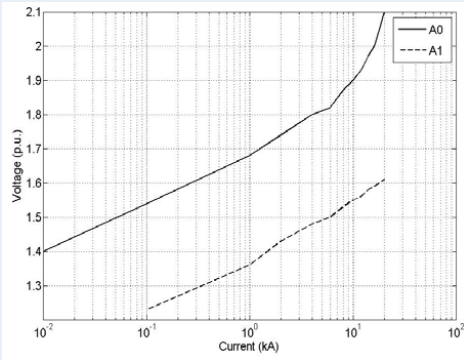


Fig 3: Characteristics of nonlinear elements A0 and A1 proposed by IEEE W.G. 3.4.11

Adjustment of V-I characteristics of A0 to match switching surge Voltages:
The value of L1 in model is adjusted with V-I characteristic of A1 and modified V-I characteristics of A0 to obtain a good match between the manufacturer data and model discharge voltages for an 8/20 µs current.
Adjustment of L1 to match V8/20 voltages:
The V-I characteristics of A0 are adjusted in surge arrester model to get a good match between model and manufacturer's switching surge voltages and currents.

Case Studies:

Considering a worst case scenario for simulation, the lightning impulse or switching impulse injected currents at HV or LV terminals of the autotransformer are selected based on the V-I characteristics of corresponding surge arresters. The generated impulse currents namely 3 kA, 30/60 *µs* switching impulse, 20 *kA,* 8/20 *µs* lightning current impulse and 20 *kA,* 0.5/20 *µs* steep front current impulse, presented in Figures 4-6 respectively, are used in the simulation. Case studies have been performed to determine need for surge arrester at tertiary of autotransformers and simulation results are presented in Figures 7-9. Based on these studies it is observed that in addition to surge arresters at HV and LV side of autotransformer, surge arresters are required at tertiary side of the autotransformer to limit the overvoltages to safe levels.

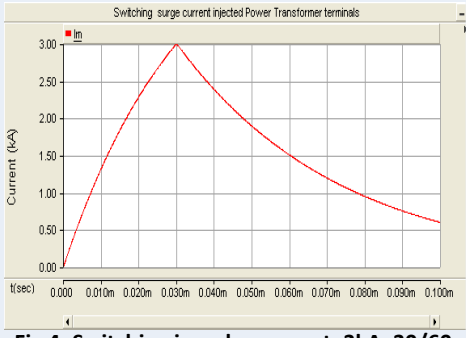


Fig 4: Switching impulse current, 3kA, 30/60 *µs*

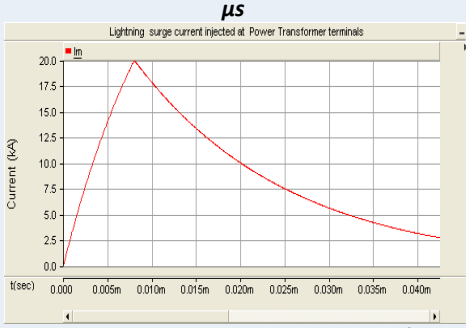


Fig 5: Lightning impulse current, 20kA, 8/20 *µs*

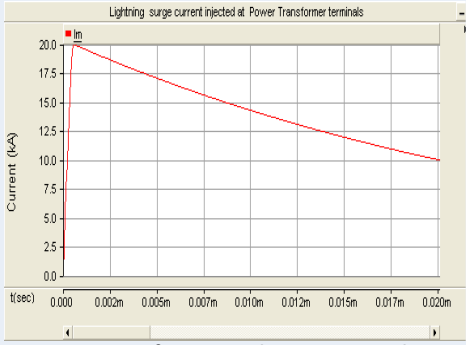


Fig 6: Steep front impulse current, 20kA, 0.5/20 *µs*

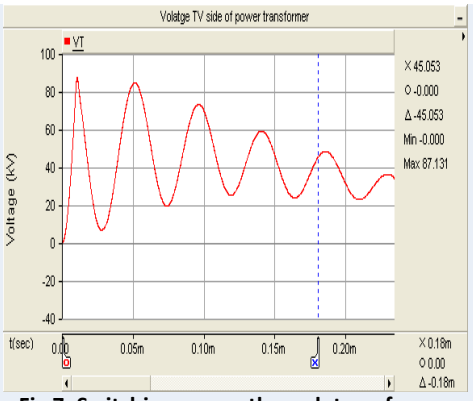


Fig 7: Switching surges through transformer

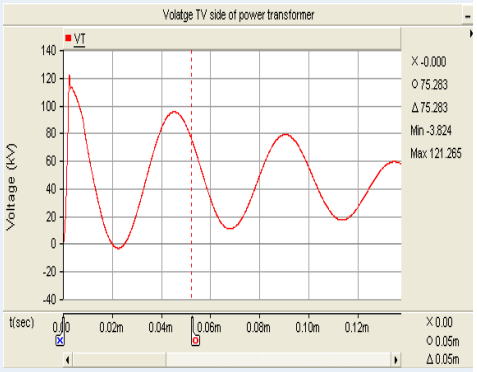


Fig 8: Lighting surges through transformer

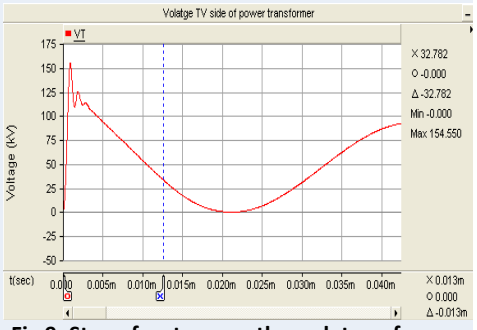


Fig 9: Steep front surges through transformer

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[2] Micaela Caserza, Marco Giannettoni, Paolo Pinceti, "*Validation of ZnO Surge Arresters Model for Overvoltage Studies*", IEEE Transactions on Power Delivery, vol. 19, no.4, Oct. 2004, pp-1692-1695.
[3]IEEE working Group 3.4.11, Application of surge protective devices subcommittee, Surge protective Devices Committee, "*Modeling of Metal Oxide Surge Arresters*", IEEE Transactions on Power Delivery, Vol. 7, no.1, January 1992, pp. 302-309.

Consultancy Services Rendered

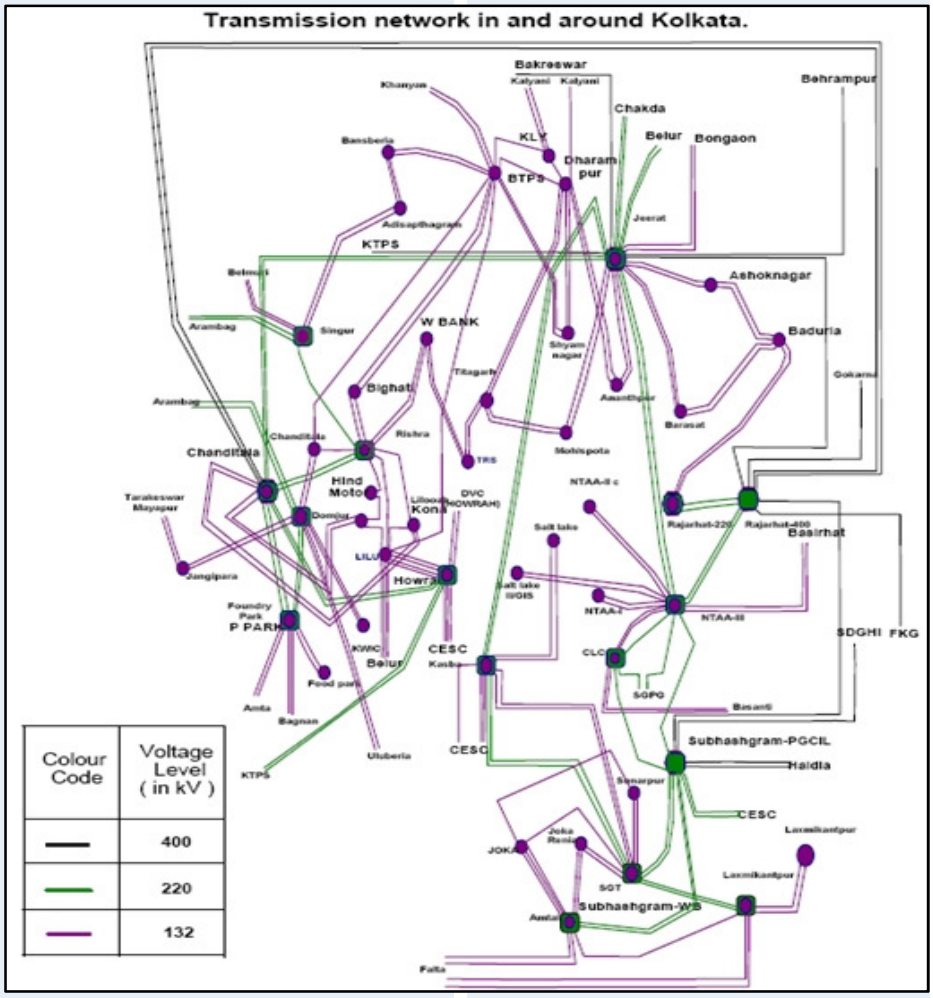
Planning Studies for West Bengal State Transmission System

Growth of power sector determines the growth of the state/country. Sustained growth in electrical industry enables sustained growth of GDP. In order to obtain sustained growth, optimal planning in the electricity industry is very much essential. Transmission planning study is one of the critical elements in this planning process which is the backbone of electricity supply system.

Transmission system planning in India is carried out in accordance with the CEA planning criteria and the Indian electricity grid code (IEGC) in order to assure security, reliability and quality of supply to consumers. PRDC has recently carried out the transmission planning studies for West Bengal state for 12th five year plan period (year 2012-13 to 2016-17) for West Bengal State Electricity Transmission Company (WBSETCL).

In transmission planning study, depending on the year wise load demand and generation capacity addition certain set of studies were performed for the years from 2012-13 to 2016-17 to assess the future requirement of substations and transmission lines. While performing the planning study in addition to the State Transmission Utility (STU) plan, Central Transmission Utility(CTU) plan has also been taken into consideration.

PRDC's in-house developed software **MiPower™** was used to perform power system studies. Single line diagrams and geographical diagrams of the networks were prepared and results were plotted and included in the report.



Load flow analysis along with contingency for peak load and off peak load conditions, short circuit analysis, stability analysis and identification of system deficiency and evaluation of technical losses have been carried out to assure required voltage profile and proper loading of elements.

The highlight of the planning study is that the voltage profile in the system has been maintained to be within the grid code limits; the loss level as a result of proper transmission planning would come down from the present level of 4.61% to 3.66% at the end of the horizon year with due focus on improving the reliability of the system.

Besides, the system is stable for all the credible contingencies.

Suitable reinforcement to alleviate Low voltage at the buses identified in the operational study is suggested.

Study also considered providing two sources for all the 132 kV substations to increase the reliability. Considering the criticality of Right of Way (ROW), it was suggested to consider multi-circuit lines and bundled conductors to increase the power carrying capacities of corridors.

Year wise studies were carried out to indicate the requirement of year wise substations/lines and investment.

Events

Two Day Tutorial on Flexible AC Transmission Systems (FACTS)

By: Dr. Rajiv K. Varma, University of Western Ontario, Canada

PRDC had organized a two-day Tutorial on **"Flexible AC Transmission Systems (FACTS)"** at Bangalore during 11-12 July 2011. The tutorial was conducted by Dr. Rajiv K. Varma, Associate Professor at the University of Western Ontario (UWO), Canada. Dr. Rajiv Varma has co-authored a book entitled "Thyristor-Based FACTS Controllers for Electrical Transmission Systems" and delivered several Tutorials on "Static Var Compensator (SVC)" conducted by the IEEE Substations Committee. He is the Chair of IEEE Working Group on **"FACTS and HVDC Bibliography".**

The tutorial was inaugurated by Prof. K. R. Padiyar, Honorary Professor, Indian Institute of Science, Bangalore in the presence of Dr. R. Nagaraja, Managing Director, PRDC. More than 30 delegates representing organizations like BHEL, GE, Powergrid, KPTCL, NPTI, CPRI participated in the event besides engineers from PRDC.
The course started with an overview of the transmission challenges of emerging electrical power systems. Besides, Dr. Varma explained the basic concepts, principles and operation of fast high power electronic controllers known as Flexible AC Transmission Systems (FACTS) that enhance power system stability and effectively increase transmission capacity thus yielding significantly higher flexibility of operation. The course focused on Thyristor Based FACTS Controllers, and also concepts and applications of Voltage Source Converters based FACTS Controllers.
There were useful interactions between the faculty and the delegates on issues like application of FACTS controllers for future projects in India, operational experience, FACTS applications in integration of renewable energy sources with the grid etc, which immensely benefited the participants.

PRDC plans to organize more such events in future.

PRDC and the Academia

VTU R&D Center

PRDC has always been associated with academia in one way or the other since inception. As the very name of the company suggests, PRDC is into Research & Development and hence close to Academia. Several B.Tech, M.Tech students and PhD Scholars from reputed institutions have done their dissertation / research work at PRDC. PRDC has signed MOU with several Academic institutions to enhance industry institute partnership.

PRDC is also recognized as a Research Center by **Visvesvaraya Technological University (VTU)** - the university to which about 250 engineering institutes of Karnataka is affiliated. This gives an excellent opportunity for the scientists, research scholars, professional engineers, in-house engineers and other interested intellectuals to pursue full time / part time MSc. (Engg) by research and Ph.D programmes at PRDC, to enhance their knowledge. This further leads to the contribution of sophisticated and innovative solutions for the ever-changing power industry.

PRDC provides an opportunity for undergraduate and postgraduate students to pursue their project work on the ongoing practical issues of the industry thereby providing practical exposure and a platform for industry-institute interaction.

Currently six research students (Three PhD & three M.Sc Engg. by Research) are pursuing their higher studies in the VTU R&D Center at PRDC.

Our Expertise in Training

Upcoming Events

At PRDC, we conduct various training programmes throughout the year. The duration of the training programme varies from one to four weeks.

One Week Training

We conduct a one week programme for MiPower Clients. It's a Standard course.

MiPower Client Training Level 1

Level 1 is a training programme on Basic Theory & Simple problems (hands-on)*

Batch:

1. 7th November 2011 to 11th November 2011

MiPower Client Training Level 2

Level 2 is a training programme which consists of only hands-on and solving own system problems, sorting out issues and clarifications*.

Batch:

1. 17th October 2011 to 21st October 2011
2. 12th December 2011 to 16th December 2011

* Participants are requested to choose the training as per their need, like Level 1 or Level 2.

Training Program@PRDC

Short Term Training /Workshop

In addition to the above said programme PRDC is also conducting short term training program and workshops to impart knowledge and practical approach on specific topics, which are of relevance to power engineers in day-to-day works. Such training not only enhances their knowledge but also helps to implement in their regular routine works.

Two-Four Weeks Training

(Customized to suit the requirements)

The course content is appropriately drafted for engineers who are experienced and also working in the field of generation, transmission, distribution, protection, relay coordination, planning of new and/or expansion of existing system etc. The course also educates the new recruits by providing both practical and theoretical exposures.

The course content is designed to hold immediate relevance to working engineers. It is very essential that the trainee receives optimum input in such deeper subjects.

Each trainee will be provided with a PC for entire training period for specific courses to provide training and hands on experience simultaneously with PRDC's indigenous software **MiPower™**.

Note:
Minimum of 15 participants and a Maximum of 20 participants per batch is required for 2/4 weeks program and 25-30 participants for short term program.

For other short term and special trainings please contact our marketing team: ***marketingteam@prdcinfotech.com***

Workshop participation

PRDC organized a workshop on **"Computer Applications in Power Systems",** in association with **Vindhyachal Institute of Technology, Indore** for three days, from 13th September to 15th September 2011.

PRDC organized a one day workshop on **"Geographical Information System (GIS)", for Transmission Utility, OPTCL,** Orissa. Dr. R. Nagaraja, MD, PRDC, Shri B. K. Mishra, Chairman, OERC, Shri Hemant Sharma, MD, OPTCL, Shri K.K. Nath, Director Engineering, OPTCL, Shri Anant Rao, CGM – IT, OPTCL were present during the inauguration.

PRDC Signs MoU with VTU

Dr. S. A. Kori, Registrar, VTU, Dr. H. Maheshappa, VC, VTU and Dr. R. Nagaraja, MD, PRDC during MoU Signing Ceremony

'PRDC has been privileged to sign a MoU with the Visvesvaraya Technological University (VTU) of Karnataka on 8th September 2011. The MoU is aimed at formulating methods of working together for strengthening research in the field of power systems and associated studies, model development, and for giving the students and faculty of VTU exposure in power system analysis, embedded system design application to power system, SCADA & EMS applications, smart gird, renewable energy front, protection co-ordination, and enable to take up R&D work in these areas. Activities planned by VTU and PRDC are:

- Jointly undertake sponsored research activities related to various applications of power systems.
- Provide industry centric training in power system studies, embedded system development and power systems.
- Carryout capacity/competency building activities for Engineering Institutes of both organizations.
- Meet the goal of establishing and operating a Center of Excellence (CoE) in the field of power systems.

On its part, PRDC shall endeavor to:

- Identify specific interdisciplinary areas of Research and Development tasks that can be carried out at University Level.
- Assist VTU in developing Project Proposals as a part of this Centre of Excellence (CoE) on power systems.
- Help VTU in identifying skills and experience required for critical projects related to power systems.
- Coordinate with VTU in getting sponsored Projects sanctioned by Government and Autonomous Funding Agencies.
- Take part, as one of the Stake Holders, in monitoring the progress of the Projects and continuously update the status of Technology Readiness Levels (TRL) and forecast future projects.
- Technical support to VTU in conducting Seminars / Symposia and Workshops and any other Knowledge Dissemination Programs.

Mr. M.M. Babu Narayanan, CTA addressing the gathering

Field visits

Visit to wind farms at Chitradurga

Visit to Powergrid Kolar HVDC Station

Our Products

MiPower™

Empowering Power System Engineers

Power Transmission and Distribution System Analysis Software Suite

Transmission Line Simulator

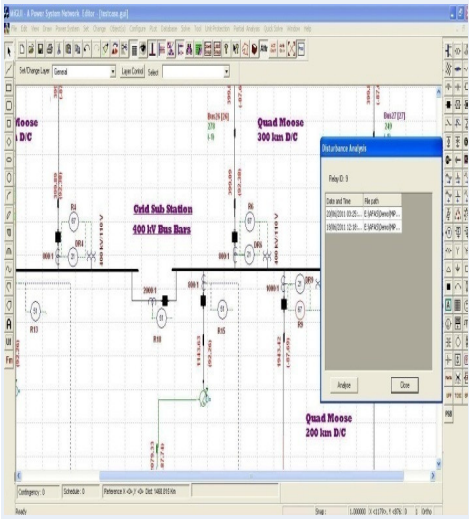
Integrated Relay Test Kits

MiFAS – MiPower Fault Analysis System

Introduction

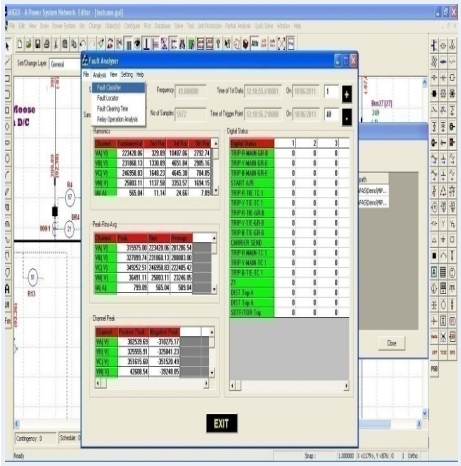
MiPower Fault Analysis System (MiFAS) is a unique package which helps in analyzing the system conditions during disturbances. MiFAS is aimed at performing various major type of analysis such as fault identification, fault classification, fault location, fault signature analysis and relay operation analysis.

MiFAS



- Inputs are considered as per IEEE standard C37.111-1991/99 COMTRADE format.
- Selection among various input files.
- Creation and Editing of network.
- Facilities for both Manual and Automated mode.
- Deriving various quantities as an output such as rms, peak, average, harmonic content etc.
- Options to provide various level of analysis.

Types of Analysis

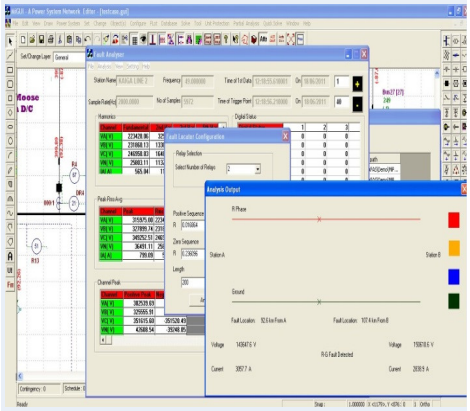


The package provides various types of analysis such as:

- Fault Classifier
- Fault Locator
- Fault clearing time
- Relay operation Analysis

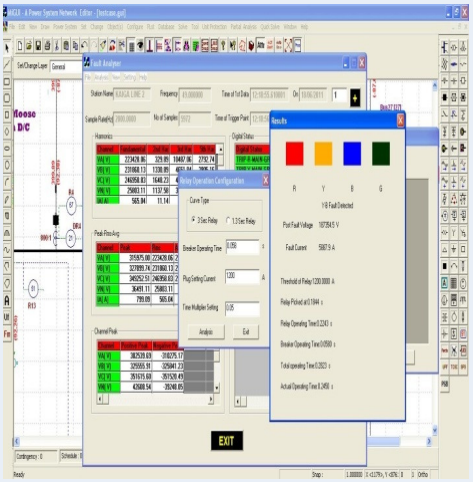
Fault Classification and Location

- MiFAS effectively differentiate between normal and abnormal conditions in the system.
- Analysis provides classification for various type of fault.
- Provides location of the fault on the transmission line by using both single ended and double ended algorithms.

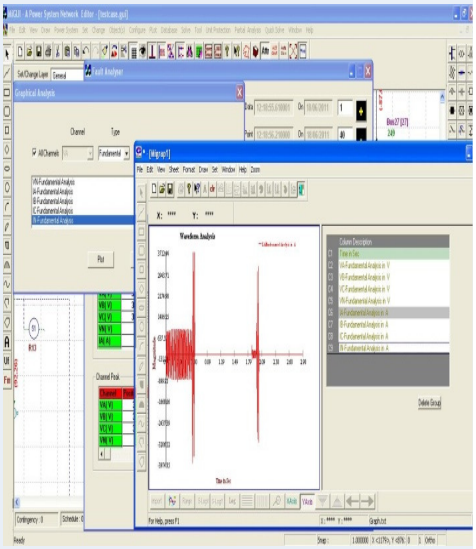


Relay Operation Analysis

- This analysis can be utilized to verify various protective schemes.
- It can assess the performance of protective schemes under critical situations.



Graphical Analysis



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