IPST 2007 Conference Program

Sunday, June 3

18:30 – 19:30 **Preliminary welcome and drink :**
in the room "Caravelle", Hotel Best Western Charlemagne, Lyon

1. Monday, June 4

08:00 – 09:30 **Conference Registration , Continental Breakfast**
Authors Breakfast

1.1 09:30 – 10:30 Opening General Session 1

Chairperson: Alain Sabot (France)

1.2 10:30 – 12:10 Paper session 2 : New Tools and New Techniques

Chairperson: Carlo Alberto Nucci (Italy)

1. Frequency Domain Transient Analysis Applied to Transmission System Restoration Studies 30

P. Gómez, P. Arellano, R. O. Mota

This paper describes a frequency-domain method to evaluate transient overvoltages produced in the restoration process of transmission systems.

2. Overhead Line Switching Surge Simulator 301

S. Sadovic, T. Sadovic

A phase-domain multi-phase switching surge transients model is introduced in order to accurately simulate switching surge transients on transmission lines. The transmission line is divided into short segments. Each segment is represented by two multi-phase ideal propagation sections, while the corresponding losses are modeled by an impedance inserted in the middle of the segment.

3. A Link Between EMTP-RV and FLUX3D for Transformer Energization Studies 94

S. Dennetière, Y. Guillot, J. Mahseredjian, M. Rioual

This paper describes a programmed link between the electromagnetic transients program EMTP-RV and the finite element electromagnetic field solver FLUX3D.

4. Object Oriented Design of a Transient Analysis Program 111

T. Noda

This paper presents a programming design methodology of an electromagnetic transient analysis program based on the object-oriented approach. The proposed methodology significantly simplifies the code, and its maintainability is enhanced.

5. Generic and Automated Simulation Modeling Based on Measurements 152

M. Tiberg, D. Bormann, B. Gustavsen, C. Heitz, O. Hoenecke, G. Muset, J. Mahseredjian, P. Werle

SoFT is a new method and tool, which measures and models electrical network components in a wide frequency band with unprecedented accuracy. The models are easily imported into most commonly used simulation software.

1.3 10:30 – 12:10 Paper session 3 : System Protection and Fault Location (1)

Chairperson: Mario Paolone (Italy)

1. Wave Propagation Regime to Point to the Faulted Feeder in Mixed Cable-and-Lines Distribution Systems with Single-Line-to-Ground Fault 115

W.-Y. Huang, R. Kaczmarek

The paper presents an analysis method of post-fault wave propagation for identifying a faulted feeder in

radial MV systems with laterals (lines or cables) and in radial mixed systems.

2. Transient Regime to Support Steady State Directional Function in Presence of Strong Capacitive Currents in Compensated MV Systems 117

W.-Y. Huang, R. Kaczmarek

The examination of polarities of after-fault currents at their first zero-crossing can help make a directional decision in cases where steady-state methods, based on the detection of the active component in faulty currents, are no longer efficient.

3. Symmetrical Components for Transient Regime Applications in MV Systems 118

W.-Y. Huang, R. Kaczmarek

Symmetrical components theory is applied to the transient after-fault regime of an MV network. The result is an extended zero-sequence circuit. It presents a better performance than any of the 0-p-n sequence networks in use, both in terms of waveform equivalence and fault parameters range in location procedures.

4. ATP-EMTP Investigation of a New Algorithm for Locating Faults on Power Transmission Lines with Use of Two-End Unsynchronized Measurements 120

M. M. Saha, J. Izykowski, E. Rosolowski, R. Molag

This paper presents a new algorithm for locating faults on two-terminal power transmission lines using unsynchronized measurements. This fault location algorithm has been tested and evaluated with fault data obtained from ATP-EMTP simulations. The sample results of the evaluation are reported and discussed.

5. ATP-EMTP Investigation of a New Fault Location Method for Multi-Terminal Power Lines 121

M. Fulczyk , P. Balcerek, J. Izykowski, E. Rosolowski, M. M. Saha

This paper presents a new algorithm for locating faults on multi-terminal power lines. The input signals are the three-phase currents measured synchronously at all line ends and the three-phase voltage at the fault locator terminal.

12:15 – 13:45 Lunch

1.4 13:50 – 15:30 Paper session 4 : System Protection Analysis and Models (1)

Chairperson: Murari Mohan Saha (Sweden)

1. Fault Resistance Influence on Faulted Power Systems with Distributed Generation 123

A. D. Filomena, R. H. Salim, M. Resener, A. S. Bretas

This paper analyzes the influence of the fault resistance on fault location methods and protection schemes of faulted power systems with distributed generation.

2. EMTP Applied to Evaluate Three-Terminal Line Distance Protection Schemes 164

K. M. Silva, W. L. A. Neves, B. A. Souza

This paper presents a technique to evaluate the performance of the protection of three-terminal transmission lines using EMTP closed-loop simulations. The distance relays are modeled including the logic of blocking and tripping distance pilot schemes.

3. On-line Discrete Wavelet Transform in EMTP Environment and Applications in Protection Relaying 251

N. Perera, A.D. Rajapakse, R.P. Jayasinghe

The paper describes the development of an on-line discrete wavelet transformation in an emtp-type simulation program. The paper presents several examples illustrating the application of the method for power system protection.

4. Analysis of Complex Faults in Distribution Systems 190

N. Solís, J. A. Gutiérrez, J. L. Naredo, V. H. Ortiz

Distribution systems are exposed to natural phenomena like storms, fall of tree branches, lightning strokes, etc. These events often cause evolutionary faults involving arc phenomena. This paper focuses on the analysis of such complex faults and explores the possibility of identifying and locating high-impedance arcing faults with conventional relays.

5. Patterns from Transient Signals in Dynamics Series Compensated Lines for Neural Protection 193

V. Ortiz, P. Zuñiga, L. Naredo, A. Gutierrez

This work presents a frequency domain solution technique to obtain fast switching transients in Flexible AC Transmission Systems (FACTS).

1.5 13:50 – 15:30 Paper session 5 : System Dynamics, SSR Studies

Chairperson: Luc Gérin-Lajoie (Canada)

1. On Effect of TCSC Structure and Synchronization Response on Subsynchronous Damping 161

P. Vuorenpää, T. Rauhala, P. Järventausta, T. Känsälä

This paper illustrates and analyses the effect of different TCSC related parameters on subsynchronous damping over the whole subsynchronous frequency range using general literature based network, component and control system structures.

2. Dynamic Stability and Optimal Control of a Multi-Machine Power Networks Modeling and Simulation 264

N. Abu-Tabak, J.Y. Auloge, P. Auriol

This paper studies the dynamic stability problem of multi-machine networks. Linear optimal control is used to improve the stability of the system. Modeling and simulation under MATLAB allows visualizing the dynamic behavior of the system.

3. Dynamic Analysis of Inverter Dominated Unbalanced LV Micro-Grids 297

N. L. Soultanis, A. I. Tsouchnikas , N. D. Hatziargyriou, J. Mahseredjian

This paper presents the modeling of low-voltage inverter-fed unbalanced micro-grids. The modeling is based on steady-state and time-domain computations using EMTP-RV.

4. Integration of a Hydraulic Production Plant in a Weak Power System on a Long Radial Line 46

P. Larivière, M. Racine

Integrating power plants on long lines and weak power systems requires some care. To this effect, a study has been conducted to determine if severe disturbances could result from integrating on a very long radial transmission line a hydraulic production plant representing only 12% of the short circuit power.

5. Determination of Study Zone for Sub-Synchronous Oscillation Analysis in Large Power Systems 263

E. P. Cheriyan, A. M. Kulkarni

The paper presents the analytical formulation of a differential-algebraic network model suitable for SSR analysis along with analytical results based on damping torque analysis of a large power system. A case study of a large power system is also presented to illustrate the methodology.

15:30 – 15:50 Coffee Break

1.6 15:50 – 17:30 Paper session 6 : System Protection Analysis and Models (2)

Chairperson: Chul-Hwan Kim (South Korea)

1. Overvoltage Problems of Small-Scale Generators Connected to Large Systems 61

J. R. Cogo, H. W. Dommel

Connecting small generators to distribution systems produces special requirements for protection, for energization of generators out of synchronism, etc. Typical EMTP studies for such problems are discussed in the paper.

2. Advantages in Using Kalman Phasor Estimation in Numerical Differential Protective Relaying Compared to the Fourier Estimation Method 63

B. Bukh, U. S. Gudmundsdottir, P. B. Holst, K. B. Jensen, L. C. Jensen, C. L. Bak

This paper demonstrates the results obtained from detailed studies of numerical differential protective relaying using Kalman phasor estimation. The results from this analysis are promising.

3. ATP Simulation of the Out-of-Step Phenomenon in the Batlle Thermal Power Plant 75

G.Calzolari, C.Saldaña

Due to an incident in the 500 kV network, a unit in the Batlle thermal power plant was tripped by an out-of-step relay. A comprehensive analysis, including an ATP simulation of the out-of-step phenomenon, was carried out in order to determine if the present settings of the out-of-step relay were correct or if they should be modified.

4. Testing and Evaluating New Software Solutions for Automated Analysis of Protective Relay Operations 288

M. Kezunovic, X. Luo, N. Zhang, H. Song

This paper briefly describes the automated analysis solutions and then discusses requirements for testing and evaluation, and outlines the implementation of the test and evaluation environment. The solution encompasses techniques that use both simulated and recorded transients and allow tests of both software modules and actual relays.

5. A MHO Distance Relay Device in EMTPWorks 179

L. Gérin-Lajoie

This paper describes in detail a generic distance relay in EMTPWorks based on using a separate evaluation of the impedance for each phase.

1.7 15:50 – 17:30 Paper session 7 : Lightning Surges (1)

Chairperson: Ivo Uglesic (Croatia)

1. Modeling of Substation Grounding for Fast Front Overvoltage Studies 100

X. Legrand, A. Xémard, P. Auriol, C. A. Nucci, C. Mouychard

This paper presents an estimation of errors due to a low frequency representation of the grounding system of a substation, when studying fast transients phenomena such as lightning.

2. A Study of Current Waves Propagating Along Vertical Conductors and Their Associated Electromagnetic Fields 107

Y. Baba, V. A. Rakov

Using the FDTD method, we have analyzed current waves propagating along vertical conductors of different type, including a cone, an inverted cone, and a thin or thick cylinder, each located above ground and excited at one of its end by a lumped current source, and their associated electric and magnetic fields.

3. Points to Consider Regarding the Insulation Coordination of GIS Substations with Cable Connections to Overhead Lines 113

M. M. Osborne, A. Xemard, L. Prikler, J. A. Martinez

The paper addresses issues arising from substation design and overvoltage protection when connecting new GIS equipment or transformers to overhead lines using cables. This paper reports on work underway within the CIGRE insulation coordination working group (C4.301)

4. Propagation of Transients in Extruded MV and HV Cables Considering Typical Thickness and Resistivity Values of Commercial Semiconductive Compounds 126

M. Marzinotto, C. Mazzetti

This paper examines the attenuation and distortion of lightning and switching surges on MV and HV cables considering typical thickness and resistivity values of commercial semiconductive compounds.

5. Computation of Energy Absorption and Residual Voltage in Metal Oxide Surge Arrester from Digital Models and Lab Tests: A Comparative Study 158

G. R. S. Lira, D. Fernandes Jr., E. G. Costa

In this work, the analysis of some metal oxide surge arresters models was carried out to compare the absorbed energy and residual voltage computed by digital simulations using EMTP with the energy obtained from lab tests of operation voltage and lightning surges.

17:45 – 19:00 Welcome Cocktail Party

2. Tuesday, June 5

08:30 – 08:50 Authors Breakfast

2.1 09:00 – 10:40 Paper session 8 : Ferroresonance

Chairperson: Bruce Mork (USA)

1. Failure of Riser Pole Arrester due to Station Service Transformer Ferroresonance 151

K. Pattanapakdee, C. Banmongkol

The explosive problems of riser pole arrester during the switching operations of disconnectors in the feeders are presented. The field tests and computer simulations by using ATP/EMTP program were conducted to confirm the cause and determine the practical solutions. Furthermore, transformer hum and movies during the arrester explosion were also recorded.

2. Ferroresonances during Black Starts - Criterion for Feasibility of Scenarios 168

L. Kocis

Permissible black-start scenarios can be specified based on energy absorption limits of the existing surge arresters on the network during ferroresonance conditions. Simulations are used to establish satisfactory scenarios, and a comparison with real events is presented.

3. A Special Ferro-resonance Phenomena on 3-phase 66kV VT-generation of 20Hz Zero Sequence Continuous Voltage 270

S. Nishiwaki, T. Nakamura, Y. Miyazaki

This paper investigates the cause of the damage to a 66kV potential transformer when clearing a 1LG fault at a refinery substation. The sustained 20-Hz zero-sequence oscillation recorded during the event was reproduced in simulations, and attributed to ferroresonance at the PT.

4. Validation of a Power Transformer Model for Ferroresonance with System Tests on a 400 kV Circuit 50

C. Charalambous, Z.D. Wang, J. Li, M. Osborne, P. Jarman

This paper describes the modeling work carried to reproduce field tests of ferroresonance due to the de-energisation of a power transformer attached to a long overhead line.

5. Ferroresonance Conditions Associated With a 13 kV Voltage Regulator During Back-feed Conditions 62

D. Shoup, J. Paserba, A. Mannarino

This paper describes ferroresonance conditions for a 13 kV feeder circuit with a voltage regulator connected under back-feed conditions, where high overvoltages developed causing the failure of distribution class surge arresters.

2.2 09:00 – 10:40 Paper session 9 : Power Electronics Applications

Chairperson: Reza Iravani (Canada)

1. Smooth Transition between Optimal Control Modes in Switched Reluctance Motoring and Generating Operation 122

C. Mademlis, I. Kioskeridis

A new control scheme for SRM drives, applicable over the entire speed range for motoring and generating operation is proposed. The optimal conditions over the entire speed range are determined and the smooth transition between the control modes is examined.

2. Limitation of Line Fault Currents with the UPFC 175

L. C. Zanetta Jr., M. Pereira

This paper presents the instantaneous characteristic response of series-connected VSI-based FACTS compensators used for limiting possible fault currents in a compensated line.

3. Performance Study of a Continuously Controlled Shunt Reactor for Bus Voltage Management in EHV Systems 18

S.V.N. Jithin Sundar, G. Vaishnavi

This paper presents a novel method of providing reactive power support for management of bus voltage in EHV substations. The new equipment known as controlled shunt reactor (CSR) can provide variable

reactive power support continuously based on bus voltage deviations.

4. Simulation and Controller Design of an Interline Power Flow Controller in EMTP-RV 66
S. Salem, V. K. Sood
In this paper, a control scheme of an Interline Power Flow Controller (IPFC) system with two VSCs to compensate the impedances of two similarly dimensioned parallel transmission lines is presented. The model is simulated with the EMTP-RV program to demonstrate the proposed control scheme of the IPFC.

5. Modeling, Control and Simulation of a Chain Link STATCOM in EMTP-RV 67
N. M. Shah, V. K. Sood, V. Ramachandran
A special STATCOM is designed by connecting a number of VSCs referred to as 'chain links', in series per phase on their AC sides.

10:40 – 11:00 Coffee Break

2.3 11:00 – 12:10 Paper session 10 : System Protection and Fault Location (2)

Chairperson: Marc Petit (France)

1. Fault detection in Primary Distribution Systems Using Wavelets 125
R. H. Salim, K. R. Caino de Oliveira, A. S. Bretas
This work presents a novel technique for fault detection using the multiresolution analysis of the voltage and current signal at the relay station, provided by the wavelet transform.

2. Detection of Earth Fault in a Medium Voltage Distribution Network 153
T. Henriksen, A. Petterteig
This paper analyses the possibility of detecting single phase ground fault with large fault resistance in a medium voltage network with natural unbalance. The paper presents field test measurements and simulations.

3. Compensation of the Secondary Voltage of a CCVT Considering Hysteresis Characteristics of the Core in Time Domain 202
Y.-C. Kang, T. Zheng, Y.-H. Kim, S.-I. Jang, Y.-G. Kim
This paper proposes an algorithm for compensating the distorted secondary voltage of the CCVT considering the hysteresis characteristics of the core in the time domain.

2.4 11:00 – 12:20 Paper session 11 : Transformers (1)

Chairperson: Michel Rioual (France)

1. On the Ringdown Transients of Transformers 229
N. Chiesa, A. Avendaño, H. K. Høidalen, B. A. Mork, D. Ishchenko, A. P. Kunze
This paper details the analysis of transformer ringdown transients that determine residual fluxes. A novel energy approach is used to analyze the causes of transformer saturation during de-energization. Coupling configuration, circuit breaker and shunt capacitor influence on residual flux have been studied. Flux-linked initialization guidelines are given at the end of the paper.

2. Implementation and Verification of the Hybrid Transformer Model in ATPDraw 124
H. K. Høidalen, B. A. Mork, F. Gonzalez, D. Ishchenko, N. Chiesa
The paper documents and verifies a new hybrid transformer model in ATPDraw. The modeling concept is described and discussed, and simulations are compared to some existing transformer models.

3. Transformer Short-Circuit Representation: Investigation of Phase-To-Phase Coupling 232
A. Avendaño, N. Chiesa, B. A. Mork, H. K. Høidalen, D. Ishchenko, F. Gonzalez, A. P. Kunze
This paper analyzes whether or not it is important to include phase-to-phase terms in the short-circuit admittance matrix. Computer simulation is used to verify both topologies of the A-matrix against experimental data.

4. Complete Analysis of Very Fast Transients in Layer-Type Transformer Windings 47
M. Popov, L. van der Sluis, R. P. P. Smeets
The paper describes the modeling and measurement of fast transients in layer-type distribution transformers. Transients at special measuring points of the transformer are measured and simulated using

a numerical method based on transmission line analysis.

12:20 – 13:50 Lunch

2.5 13:50 – 15:30 Paper session 12 : Lightning Surges (2)

Chairperson: Sandoval Carneiro (Brazil)

1. Customer Indoor Surge Phenomena due to Lightning Strike on the Joint Pole of Power Line and Telecommunication Line 253

M. Ikuta, A. Asakawa, S. Yokoyama, M. Soeda

In order to examine how surge phenomena can appear on customer premises, we simulated various cases where lightning strikes a pole on which a distribution line and a telecommunication line are jointly mounted, using a large impulse voltage generator with an experimental distribution line, and EMTP analysis.

2. Analysis of Tower Footing Resistance Effected Back Flashover Across Insulator in a Transmission System 290

P. Yadee, S. Premrudeepreechacharn

This paper studies how tower footing resistance affects the backflash voltage across insulators in the Electricity Generating Authority of Thailand (EGAT) system. Lightning overvoltages causing backflash overvoltages at insulators are simulated using PSCAD/EMTDC, and the results are compared to calculations made using the TFLASH program.

3. Surge Voltages and Currents into a Customer due to Nearby Lightning 92

A. Ametani, K. Matsuoka, H. Omura, Y. Nagai

This paper investigates experimentally an incoming path of a lightning surge into a customer due to nearby lightning, and four paths are observed depending on a lightning strike to a distribution line, a communication line, a TV antenna and nearby ground. EMTP simulation results are compared with experimental results.

4. Assessment of the Lightning Flashover Rate of a Shielded Transmission Line Protected by Surge Arresters 97

J. A. Martinez-Velasco, F. Castro-Aranda

The paper presents the application of the ATP to a study whose main goals are to estimate the probability of surge arrester failure and the flashover rate improvement achieved by these arresters, considering the possibility that they are not installed at all line phases.

5. Lightning overvoltages in HV-EHV “mixed” overhead-cable lines 230

L. Colla, F. M. Gatta, A. Geri, S. Lauria

This paper analyzes lightning overvoltages affecting HV-EHV mixed overhead cable lines, due to direct lightning strokes to the overhead portion of the line.

2.6 13:50 – 15:30 Paper session 13 : Switching Transients

Chairperson: Mark Osborne (UK)

1. Transient Analysis of Capacitor Bank Installation at Distribution Stations with PSCAD/EMTDC 103

P. Wang, D. Muthumuni, Z. Zhou, J. C. Alonso, P. Wilson, R. Wachal, J. Waddell

This paper presents details of various PSCAD/EMTDC models of the MH distribution system to determine required inductance for limiting both inrush and out-rush transient currents, frequency scans for network compliance, arrester energy duty during transient over-voltage (i.e. re-strikes and fault clearing), and breaker TRV ratings. Based on the transient analysis, several recommendations are suggested to modify the installation.

2. Control of Switching Overvoltages and Transient Recovery Voltages for Hydro-Québec 735-kV Series-Compensated Transmission System 23

Q. Bui-Van, A. Lecompte, N. Leblanc, P. Larivière

This paper summarizes the results of transient simulation studies assessing transmission line insulation coordination and the performance of line circuit breakers that are to be used in the Hydro-Quebec 735-

kV series-compensated system.

3. Flashovers at a 33-kV Filter Reactor during Energization 294

M. Kizilcay, K. Teichmann, A. Agdemir, G. Kaflowski

During the system startup of 33-kV 5th-harmonic filters on an industrial system, flashovers have occurred between the two coil parts of the reactors in two of the three phases. This paper shows how overvoltages can be produced during energization of the filter, which may cause f1ashovers at the filter reactor.

4. Electromagnetic Interference in the Substation Jose up 400/115 kV 55

G. Carrasco

Transient electromagnetic interference has been detected in substation control and measurement cables when operating a 400 kV disconnect switch. ATP simulation results show how interference on low-current control and instrumentation cables can cause unwanted equipment tripping.

5. JET Fusion Experiment 36 kV Enhancement Studies 82

K. S. Smith

This paper describes the unique pulsed power characteristics of the electrical loads at JET, the world's largest experimental magnetic confinement nuclear fusion tokamak. It discusses how EMT simulations have been used to identify the best engineering solution using pyrotechnic fault current limiters to the conflicting problems caused by poor voltage regulation and limited switchgear fault current breaking capacity.

15:30 – 15:50 Coffee Break

2.7 15:50 – 17:30 Paper session 14 : Switching Transients, Circuit Breakers

Chairperson: Akihiro Ametani (Japan)

1. New Approach Towards Very Fast Transients Suppression 167

W. Piasecki, G. Bywalec, M. Florkowski, M. Fulczyk, J. Furgał

The paper presents a new approach towards suppressing VFTs using a compact series impedance upstream from the protected equipment. The protective device is suitable for protecting transformers connected to low-loss cable lines with vacuum circuit breakers, by efficiently suppressing overvoltages and HF oscillations associated with switching operations.

2. Analyzing TRV of CB When Installing Current Limit Reactors in UHV Power Systems 140

H. S. Park, J. W. Woo, J. W. Kang, K. S. Han, S. O. Han

The CLR makes a significant contribution to the severity of the TRV experienced by the feeder and bus circuit breakers when clearing feeder faults. Based on the conclusions of an investigation of actual circuit breaker failures while performing this duty, the mitigation of the TRV associated with the reactors is described.

3. Analysis on Transients Recovery Voltage of Circuit Breaker according to Different Loads Condition at 345 kV MTR Tertiary Side 145

J. W. Woo, K. S. Han, J. Y. Yoon, D. J. Kweon, Y. J. Won

This paper investigates the transient phenomena due to the switching of different types of loads. ATP-EMTP simulation results are compared with TRV standards of KEPCO, IEC and IEEE.

4. Effects of Phase-Shifting Transformers, and Synchronous Condensers on Breaker Transient Recovery Voltages 180

W. Chandrasena, B. Bisewski, J. Carrara

This paper describes special considerations involved in determining the most limiting rate of rise of recovery voltage (RRRV) and in defining mitigation measures for 115 kV breakers in the presence of a phase shifting transformer and shunt capacitor banks.

5. Vacuum Circuit Breaker Model : Application Case to Motors Switching 48

C. Vollet, B. de Metz-Noblat

Several failures have occurred on HV motors switched by vacuum circuit breaker in spite of the installation of surge arresters. ATP network simulations show that full motor protection is provided by installing CR surge suppressors in addition to the existing MOA arresters.

2.8 15:50 – 17:30 Paper session 15 : Solution methods and modeling techniques (1)

Chairperson: Taku Noda (Japan)

1. Computer-Aided Sensitivity Analysis for Optimal Systems 181

M. Heidari, S. Filizadeh, A. M. Gole

The paper describes a novel sensitivity analysis method for complex optimal nonlinear systems.

2. A Calculation Method of Neutral Current of Two Step Type Pole in Distribution Line 192

K. W. Park, S. B. Rhee, H. C. Seo, C. H. Kim

Neutral current in three-phase four-wire distribution systems is often the result of phase imbalance. This paper conducts the calculation and analysis of neutral current for 1-step and 2-step pole configuration using equivalent circuit analysis, vector analysis and EMTP simulation.

3. Passivity Enforcement via Residues Perturbation for Admittance Representation of Power System Components 204

B. Porkar, M. Vakilian, S. M. Shahrtash, M. R. Iravani

The passivity violation regions are detected via a purely algebraic approach based on the existence of purely imaginary eigenvalues in the Hamiltonian matrix obtained from the state-space representation of the reduced-order model. Also a fast test method is presented to check passivity without direct calculation of eigenvalues of the Hamiltonian matrix.

4. Time Labelling for Fast Transients 259

U. Grasselli, D. Di Erasmo

This paper presents the characterization of fast transients in power systems using the discrete wavelet transform (DWT) for voltage transient reference time estimation under GNSS synchronization.

5. Sensitivity Studies for AC Railway Networks Design 283

P. Fayet, P. Auriol, G. Clerc

This paper presents a simulation tool for designing railway networks. A comparison between different line models and sensitivity studies on the influence of earth resistivity and rail-to-earth impedance and conductance values are presented.

3. Wednesday, June 6

08:30 – 08:50 Authors Breakfast

3.1 09:00 – 10:40 Paper session 16 : Switching Transients, Lines and Cables

Chairperson: Laszlo Prikler (Hungary)

1. A Comparison of the Performance of a Conventional Transmission Line and Expanded Bundle Regarding Transient Overvoltages 186

F. R. Alves, O. Regis Jr.

This paper presents an analysis of line overvoltages for transformer energization, load rejection and three-phase reclosing of a 500 kV TL, comparing the use of two configurations of 4-conductor bundles. The expanded bundle approach leads to higher reactive shunt compensation requirements and to higher overvoltages when compared to using a standard bundle configuration.

2. A Wavelet-Based Algorithm for Disturbances Detection Using Oscillographic Data 210

F. B. Costa, K. M. Silva, K. M. C. Dantas, B. A. Souza, N. S. D. Brito

This paper presents a discrete wavelet transform approach to disturbance detection by the analysis of electromagnetic transients in transmission lines using oscillographic data.

3. Temporary Overvoltages due to Harmonic Resonance in Long EHV Cables 233

L. Colla, S. Lauria, F. M. Gatta

Long, shunt-compensated EHV AC cables are energized in a block with shunt reactors. Harmonics from reactor inrush currents can excite low resonant frequencies of the cable-network system, giving rise to significant temporary overvoltages.

4. Analysis and Simulation of Switching Surge Generation when Disconnecting a Combined 400 kV Cable/Overhead Line with Shunt Reactor 24

C. L. Bak, W. Wiechowski, K. Søgaard, S. Damsgaard Mikkelsen

This paper demonstrates analysis, simulation and measurements of the generation of switching overvoltages during last-end disconnection of a 400 kV line consisting of both cable and overhead line sections and a permanently connected shunt reactor.

5. Comparative Analysis of Control Switching Transient Techniques in Transmission Lines Energization Maneuver 242

P. Mestas, M. C. Tavares

The objective of this paper is to analyze the overvoltages level generated in a transmission line during energization for different mitigation devices. Such a survey is basic for inferring the performance of the "conventional methods" of control such as using pre-insertion resistors and/or surge arresters versus synchronized closing of circuit breakers.

3.2 09:00 – 10:30 Paper session 17 : Wind Turbine Transients and Harmonics

Chairperson: Maria Teresa Correia de Barros (Portugal)

1. Power Quality Measurements Performed on a Large Wind Park at Low and Medium Voltage Level 147

E. Ghiani, F. Pilo, G. G. Soma, G. Celli

This work investigates the impact of wind parks on the power quality of distribution networks. Field measurements provide important indications about the real effects of integrating large interruptible renewable energy sources in power systems.

2. Analysis on Back-Flow Surge in Wind Farms 156

Y. Yasuda, T. Funabashi

This paper analyzes incidents of surge arrester burnout at wind farms due to winter lightning. Simulations help clarifying how the back-flow surge propagates from the struck turbine to other turbines, and how arrester burnout conditions can be reduced by interconnecting the turbines with grounding wires.

3. Effective Length of Long Grounding Conductor in Windfarm 196

S. Sekioka, T. Funabashi

The authors derived an analytical time-domain formula of the sending- and receiving-end voltages on long grounding conductors based on the lattice diagram method. The formula provides a clear physical meaning of the surge characteristic of the grounding conductor, and gives the effective length for lightning currents in the time domain.

4. Experimental and Analytical Studies of Lightning Overvoltages in Wind Turbine Generation Systems 58

K. Yamamoto, T. Noda, S. Yokoyama, A. Ametani

This paper presents experimental and analytical results of lightning protection studies of wind turbine generation systems using a reduced-size wind turbine model. The travelling-wave phenomena caused by summer and winter lightning are clarified on the basis of the measured waveforms and confirmed using finite-difference time-domain analysis.

10:40 – 11:00 Coffee Break

3.3 11:00 – 12:20 Paper session 18 : Solution methods and modeling techniques (2)

Chairperson: Juan A. Martinez-Velasco (Spain)

1. High-Frequency Impedance Estimation and Equivalent with N4SID 36

L. Gérin-Lajoie, I. Kamwa

This paper describes a time-domain multiple-input multiple-output system identification technique for high-frequency impedance validation. The technique uses white-noise sources in EMTP along with state-space matrices generated from MATLAB to analyse the frequency behavior of circuits for which only a time-domain representation is available.

2. Interfacing Convolution Based Linear Models to an Electromagnetic Transients Program 44

B. Gustavsen, O. Mo

This paper describes the implementation of terminal equivalents and transfer functions in PSCAD via a user-defined subroutine. The implementation involves a companion model and convolutions. Computational advantages are demonstrated.

3. Improved Simulation of an HVDC Test Case through Power-flow Initialization 73

N. Murray, J. Arrillaga, N. R. Watson, Y. H. Liu

The purpose of the proposed control is to eliminate the reactive power interdependence at the two terminals of the multi-level HVDC schemes. The new concept (referred to as multi-group firing-shift control) applies to self-commutating bipolar current-source multi-level HVDC transmission with two or more converter groups at each terminal. The Multi-level Current Reinjection (MLCR) configuration is used as a basis for the test.

4. Inaccuracies in Network Realization of Rational Models Due to Finite Precision of RLC Branches 95

A. C. S. Lima, B. Gustavsen, A. B. Fernandes

This paper examines the impact of the finite precision of RLC branches in the synthesis of frequency dependent networks. Some mitigation procedures are also investigated.

3.4 11:00 – 12:20 Paper session 19 : Transmission Lines and Cables (1)

Chairperson: Hermann Dommel (Canada)

1. EMTP Modeling of a Distribution Line for Lightning Overvoltage Studies 114

S. Matsuura, T. Noda, A. Asakawa, S. Yokoyama

This paper proposes an EMTP model of a distribution line for the calculation of lightning overvoltages. The proposed model can accurately reproduce lightning overvoltages at the insulators in a very short time range, which cannot be simulated by conventional models.

2. Accurate Electromagnetic Transient Simulations of HVDC Cables and Overhead Transmission Lines 101

H. M. J. De Silva, A. M. Gole, L. M. Wedepohl

The paper introduces a new method for time-domain modeling of an HVDC system that is accurate at dc as well as at high frequencies. This is achieved by a modification to the vector fitting procedure.

3. Dynamic Harmonic Domain Transmission Line Modeling for Transients 106

J. J. Chavez, A. Ramirez, J. L. Naredo

Harmonics have become a relevant topic as the number of nonlinear elements and electronic devices connected to power systems is increasing constantly. This paper presents a methodology for the modeling of single-phase transmission lines interfaced with nonlinear loads.

4. Propagation Characteristics and Overvoltage Analysis on Unconventional Submarine Cables 127

P. E. D. Rocha, A. C. S. Lima, S. Carneiro Jr.

This paper analyzes an unconventional type of cable usually employed in the oil industry known as umbilical cable in terms of its propagation characteristics. An overvoltage analysis is also presented.

12:15 – 13:45 Lunch

3.5 13:50 – 15:20 Paper session 20 : Transmission Lines and Cables (2)

Chairperson: Luis Naredo (Mexico)

1. Accurate Transmission Line Modeling Through Optimal Time Delay Identification 144

L. De Tommasi, B. Gustavsen

This paper compares various techniques for delay extraction and fitting with emphasis on accuracy and computational efficiency.

2. Evaluating the Importance of Properly Representing Actual Transmission Line Transposition for Electromagnetic Transient Studies 239

A. V. Elguera, M. C. Tavares, C. M. Portela

This paper presents an analysis pointing out the inaccuracies of representing a line with actual transposition sections as an ideally transposed line for all frequency ranges in an electromagnetic transient study. A line with actual transposition can have coupling between components, which can be excited by the network terminals interaction. The interaction between line and network terminals with frequency coupling was also analyzed.

3. Transient Voltage Stress of 400 kV Urban System Evaluated by Numerical Calculations 262

S. Pack, S. Kornhuber, F. Reisinger

This paper deals with numerical investigations to evaluate the transient behavior of a close combined 400 kV urban system. The major aspect of this work is the close connection of an overhead line, a cable section and a GIS 400 kV substation. Different circuit states and the energy consumption of the arrestors are of interest.

4. EMTP Simulations and Theoretical Formulation of Induced Voltages to Pipelines from Power Lines 70

A. Ametani, Y. Hosakawa

This paper develops a theoretical formulation of induced voltages to cascaded pipelines from power lines. The formulation is useful for explaining numerical simulation results from the physical viewpoint and also to carry out parametric analyses using simulation. EMTP simulation results are shown together with theoretical solutions and field test data.

3.6 13:50 – 15:30 Paper session 21 : Power Quality and Harmonics

Chairperson: Toshihisa Funabashi (Japan)

1. Harmonic and Loss Analysis of Space-Vector Modulated Converters 105

A. Mehrizi-Sani, S. Filizadeh, P. L. Wilson

The papers addresses an implementation of the SVM method in a transient simulation tool. It also presents a comprehensive analysis of the harmonic spectrum of the voltage waveforms under various operating modes.

2. Impact and Characterization of Voltage Transients as a Problem to Sensitive Loads 254

H. Ribeiro, V. Anunciada

This paper introduces the relation between the behavior of SMPS and PQ phenomena. The paper presents a concise overview of PQ phenomena concerning SMPS behavior and their design principles.

3. Practical Modeling of Large Rectifier Loads for the Estimation of Low-order Non-characteristic Harmonics 45

M.O. Roux, A. Coutu, G. Beaulieu

The paper is meant to show a simple and practical approach for modeling rectifier loads in the estimation of low-order non-characteristic harmonics.

4. Modeling of the Behavior of Power Electronic Equipment to Grid Ripple Control Signal 80

X. Yang, S. Dennetière

The ripple control signal used by the grid may be partially absorbed by power electronic devices whose impedance at 175Hz is relatively low. The results of this study provide reasonable impedance values of some power electronic devices, instead of infinite values used until now. These values can be integrated in frequency domain simulation tools which are widely used by power quality engineers.

5. EMTP Model for Analysis of Distributed Generation Impact on Voltage Sags 96

J. A. Martinez-Velasco, J. Martin-Arnedo

This paper is aimed at analyzing the impact that DG sources can have on the characteristics of voltage sags caused in distribution networks considering both the effect that the protection system has on these voltage sags and the effect that new DG sources can have on the protection system performance.

15:30 – 15:50 Coffee Break

3.7 15:50 – 16:50 Paper session 22 : System Protection and Fault Location (3)

Chairperson: Vijay Sood (Canada)

1. Continuous-Wavelet Transform for Fault Location in Distribution Power Networks: Definition of Mother Wavelets Inferred from Fault Originated Transients 271

A. Borghetti, M. Bosetti, M. Di Silvestro, C.A. Nucci, M. Paolone

The paper presents a fault location algorithm for distribution networks based on wavelet analysis of the voltage waveforms of the traveling waves recorded at a bus during the fault. In particular, the proposed procedure implements the continuous wavelet transform combined with the use of mother wavelets inferred from the fault-originated transient waveforms.

2. A Novel Fault Location Scheme on Korean Electric Railway System Using the 9-Conductor Representation 287

H. Lee, C. Lee, H. Lee, G. Jang, S. Chang

It is important to calculate fault location in an electric railway system. However, a fault location scheme applied on field has errors. To overcome this error and to meet the problem quickly, this paper suggests a novel fault location scheme using boost wire.

3. DWT-Based Detection and Transient Power Direction-Based Location of High Impedance Faults Due to Leaning Trees in Unearthed MV Networks 31

N. I. Elkalashy, M. Lehtonen, H. A. Darwish, A-M. I. Taalab, M. A. Izzularab

This paper studies the detection of a high impedance arcing fault based on DWT and wireless sensors. The detection is carried out by extracting the initial transients inherent in the residual voltage of different measuring nodes.

3.8 15:50 – 16:50 Paper session 23 : Lightning Surges (3)

Chairperson: Bjorn Gustavsen (Norway)

1. Lightning Induced Voltage on Telephone Cables and Power Systems 160

A. S. Ahmad, T. Aka-Ngnui

The aim of this paper is to determine and analyze the effects of direct lightning strikes to the incoming power line MV and communication cables at the communication site equipments, for a real configuration, in order to optimize the protection.

2. Lightning Overvoltages on Low Voltage Circuit Caused by Ground Potential Rise 197

S. Sekioka, K. Aiba, S. Okabe

This paper describes a convenient model based on Thevenin's theorem to simulate the lightning overvoltages on residential low-voltage circuits in the case of lightning to ground. The model can be easily realized in EMTP. Simulation results using the proposed method in EMTP show that the ground potential rise causes the damages in the low voltage circuit.

3. Backflashover Analysis for 110-kV Lines at Multi-Circuit Overhead Line Towers 293

M. Kizilcay, C. Neumann

Influence of the various factors on the backflashover of the 110-kV insulator strings at multi-circuit towers with 380-kV, 220-kV and 110-kV circuits has been studied by means of ATP-EMTP simulations. Different flashover methods are compared.

17:00 Departure for the visit and the gala dinner

4. Thursday, June 7

08:30 – 08:50 Authors Breakfast

4.1 09:00 – 10:40 Paper session 24 : Real-Time Simulation (1)

Chairperson: Ani Gole (Canada)

1. Real-Time Estimation of a Delta Winding Current in a Wye-Wye-Delta Transformer 216

Y.-C. Kang, B.-E. Lee, M.-S. Lee, S.-I. Jang, Y.-G. Kim

This paper proposes an algorithm for estimating a delta winding current for a Y-Y-D transformer in real-time. The algorithm is tested in various conditions including magnetic inrush and over-excitation.

2. PC-Cluster-Based Real-Time Simulation of an 8-Synchronous Machine Network with HVDC Link using RT-LAB and TestDrive 65

C. Dufour, J.-N. Paquin, V. Lapointe, J. Bélanger, L. Schoen

This paper presents the real-time simulation of a medium-sized network composed of 8 synchronous machines connected with a 12-pulse HVDC link. The network is modeled with SimPowerSystems, discretized with ARTEMIS and executed in real-time under RT-LAB. The FPGA-based I/O interface is user-customized with the use of Xilinx System Generator.

3. Voltage Source Converter Modeled in RTDS - Experiences and Comparison with Field Results 76

T. Larsson, J.-P. Hasler, P. Forsyth, T. Maguire

The paper deals with the real time testing of controls for a VSC based compensator using an RTDS simulator. Simulation techniques are discussed and a comparison is made between off-line simulation, real time simulation and field measurements.

4. Real Time Simulation of Internal Faults in Synchronous Machines 90

A. B. Dehkordi, A. M. Gole, T. L. Maguire

The paper describes the development of a real-time digital simulator model for faulted synchronous machines. The model accurately considers arbitrary winding geometries and local saturation effects. The model is intended for use testing of relay equipment for synchronous machines.

5. An FPGA-Based Real-Time Digital Simulator for Power Electronic Systems 99

M. Matar, R. Iravani

Closed loop testing of digital controllers for power electronic systems requires simulating the system in real-time with a fairly low time step to reduce simulation errors. An FPGA-based real time digital simulator that can operate with a time step of less than 100ns is introduced.

4.2 09:00 – 10:00 Paper session 25 : Transformers (2)

Chairperson: Jean-Pierre Taisne (France)

1. Switching Surges in Transformer Provoked by Sequential Tripping of Circuit Breakers 143

I. Uglešić, I. Ivanković, V. Milardić

A study of switching surges in a 400 kV substation was carried out in order to detect the causes of damage to the power transformer. After sequential tripping of the breakers, the surge arresters installed on the tertiary windings inside the transformer were destroyed.

2. Energization of Two Transformers in Series Through Long Lines: Correlation Between Fluxes in Both Transformers, and Determination of the Efficiency of Palliative Solutions 146

M. Rioual, M. Martinez

This paper describes the energization of two power transformers in series through a 200 km 400 kV transmission line. A relation between the residual fluxes in both transformers have been shown, leading to a drastic reduction of residual fluxes values to be considered. Palliative solutions are also discussed.

3. Validation of Power Plant Transformers Re-energization Schemes in case of Black-Out by Comparison Between Studies and Field Tests Measurements 257

F.-X. Zgainski, B. Caillault, V.-L. Renouard

The EHV network and power plant restoration plan is a key process of a fast re-energization of customers. The first step after a black-out consists in re-energizing lines and transformers, both on the network and in power plants, as soon as possible and without taking too many risks. To validate the strategy based on identified schemes, we have to deal with comparison between on site tests and simulations.

10:40 – 11:00 Coffee Break

4.3 11:00 – 12:20 Paper session 26: Real Time Simulation (2)

Chairperson: Christian Dufour (Canada)

1. A Wide Band Multi Port Equivalencing Method for Real Time Digital Simulators 129

X. Lin, A. M. Gole, M. Yu

An accurate multi port wideband equivalent for RTDS is proposed, which preserves both the high frequency and low frequency behaviors of the power system. The proposed equivalent includes a FDNE and a TSA type solution block.

2. Studies on Grid Impacts of Distributed Generation in a Combined Real-Time Simulation Environment 149

K. Mäki, A. Kulmala, S. Repo, P. Järventausta

The paper presents studies in which a novel combined real-time simulation environment is applied. The environment consists of RTDS and dSPACE systems. The simulations cover grid impacts of distributed generation located in distribution network.

3. Real Time Simulation Testing Using IEC 61850 177

M. Desjardine, P. Forsyth, R. Mackiewicz

The paper describes the hardware and software requirements and implementation to achieve closed loop testing of IEC 61850 compliant IED's using a real time simulator.

4. Testing the Quality of PMU Output Data Based Subsynchronous Damping Analysis in Real-Time Simulation Environment 203

T. Rauhala, P. Järventausta

This paper presents an approach on subsynchronous damping analysis based on PMU output data. The paper presents the tests performed using RTDS in order to evaluate the quality and verify the validity of damping analysis.

4.4 11:00 – 12:20 Paper session 27: Transformers (3)

Chairperson: Mustafa Kizilcay (Germany)

1. Analysis of High Frequency Oscillations in Voltage Transformer 81

Y. Shibuya, K. Wada, H. Muto

A high frequency model of voltage transformer is proposed. Dissipations due to skin and proximity effects are taken into account. Frequency and time domain analyses are verified by an experiment. It is found that the interlayer insulation near the terminal is highly stressed.

2. Application of TCSC to Mitigate the Impact of Transformer Inrush Current on Power Quality 42

M. Khederzadeh

Transformer energization can create voltage sags which may affect sensitive loads, its extent depending on the short circuit MVA at the source bus, and the magnitude and decay time constant of the transient current. The TCSC's different modes of operation change the line impedance and likely the fault level, and so affect transformer inrush current. The application of TCSC to mitigate its impacts is investigated.

3. An Improved MTL Modeling of Transformer Winding 150

S. M. H. Hosseini, M. Vakilian, G. B. Gharehpetian

This paper presents a novel approach for modeling transformer windings using Multi-conductor Transmission Line (MTL) theory. In this model the loss factor coefficient and dielectric constant have been considered as frequency dependent parameters based on the different alternatives.

4. Transformer Mechanical Stress Caused by External Short-Circuit: A Time Domain Approach 174

A. C. de Azevedo, A. C. Delaiba, J. C. de Oliveira, B. C. Carvalho, H. de S. Bronzeado

This paper aims to present the results of investigations on the study of mechanical stresses in transformers due to short-circuit currents using a time-domain transformer model.

12:30 – 13:00 **Closing Session**

13:00 – 14:00 **Lunch**

14:00 **Departure to the railway stations or a technical visit**