BIBLIOGRAPHY OF RELAY LITERATURE, 1996 IEEE COMMITTEE REPORT

Members of the Bibliography and Publicity Working Group of the IEEE Power System Relaying Committee are:
T.S. Sidhu, Chairman, M. Bajpai, A. Darlington, D. Finley, A.G. Folkman, M. Kezunovic,
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ABSTRACT - The latest of a series of classified lists of power system relaying references, begun in 1927, is presented. This bibliography is in continuation to the bibliographies of relay literature which were published previously and are contained in the following volumes of the IEEE Transactions:

Bibliography	**Particulars of the Transaction**				
for	Volume	No.	Year	Page# from	to
1927-1939	60		1941	1435	1447
1940-1943	63		1944	705	709
1944-1946	67	pt. I	1948	24	27
1947-1949	70	pt. I	1951	247	250
1950-1952	74	pt. III	1955	45	48
1953-1954	76	pt. III	1957	126	129
1955-1956	78	pt. III	1959	78	81
1957-1958	79	pt. III	1960	39	42
1959-1960	81	pt. III	1962	109	112
1961-1964	PAS-85	10	1966	1044	1053
1965-1966	PAS-88	3	1969	244	250
1967-1969	PAS-90	5	1971	1982	1988
1970-1971	PAS-92	3	1973	1132	1140
1972-1973	PAS-94	6	1975	2033	2041
1974-1975	PAS-97	3	1978	789	801
1976-1977	PAS-99	1	1980	99	107
1978-1979	PAS-100	5	1981	2407	2415
1980-1981	PAS-102	4	1983	1014	1024
1982-1983	PAS-104	5	1985	1189	1197
1984-1985	PWRD-2	2	1987	349	358
1986-1987	PWRD-4	3	1989	1649	1658
1988-1989	PWRD-6	4	1991	1409	1422
1990	PWRD-7	1	1992	173	181
1991	PWRD-8	3	1993	955	961
1992	PWRD-10	1	1995	142	152
1993	PWRD-10	2	1995	684	696
1994	PWRD-11	3	1996	1251	1262

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PE-161-PWRD-1-04-1997 A paper recommended and approved by the IEEE Power System Relaying Committee of the IEEE Power Engineering Society for publication in the IEEE Transactions on Power Delivery. Manuscript submitted March 21, 1997; made available for printing April 11, 1997.

The papers listed include references to the subjects of service restoration, testing and methods of calculation, as well as to the field of relaying. Only the more readily available foreign publications are included.

Each reference includes the title, author, publication information, and a very brief summary of the subject matter. The listing of the titles is subdivided into ten sections, depending upon the general substance of each article. The section titles are as follows:

3150 **RELAYING ALGORITHMS**
3151 **DISTRIBUTION AND NETWORK PROTECTION**
3151.1 Industrial and Power Station Auxiliaries
3151.2 Primary Distribution Systems
3152 **TRANSMISSION LINE PROTECTION**
3152.1 Distance and Ground Relaying
3152.2 Relay Communications
3152.3 Relay Systems
3153 **RELAY INPUT SOURCES**
3154 **ROTATING MACHINERY PROTECTION**
3155 **OTHER PROTECTION**
3155.1 Transformer and Reactor Protection
3155.2 Capacitor Bank and Static Var Protection
3155.3 Other Protection
3156 **FAULT AND SYSTEM CALCULATIONS**
3157 **MAINTENANCE, TESTING, ANALYSIS, AND MODELING**
3158 **STABILITY, OUT OF STEP, RESTORATION**
3159 **SURGE PHENOMENA**

The entries in each section are listed in alphabetical order by the name of the first author. Each title is listed in only one section even if it covers material that belongs to several sections. A list of the periodicals which have been cited and the addresses of their publishers follows the bibliography.

The abstracts of many articles reported in this paper are available in the Science Abstracts - Section B, the Engineering Index, and other digesting and/or indexing periodicals.

ADDITIONAL REFERENCES

Electrical & Electronics Abstracts, are published monthly by the Institution of Electrical Engineers (U.K.) and the Institute of Electrical and Electronics Engineers, Inc. (USA).

Papers and journals published in several countries are covered.

3150 RELAYING ALGORITHMS

Development of a Numerical Comparator for Protective Relaying, Part 1, F. Calero; Part 2, D. Hart, D. Novosel, F. Calero, E. Udren, L. Yang; IEEE Trans. on Power Delivery, Vol. 11, No. 3, Jul 1996, Part 1 p 1266-73, Part 2 p 1274-84. The Part 1 paper describes a new magnitude comparator algorithm suitable for all types of protective relaying units. The Part 2 paper describes the testing of the new numerical relaying concept presented in Part 1. A broad range of test cases are presented and the results compared with conventional relaying schemes.

An Online Relay Coordination Algorithm for Adaptive Protection Using Linear Programming Technique, B. Chattopadhyay, M. S. Sachdev, T. S. Sidhu, IEEE Trans. on Power Delivery, Vol. 11, No. 1, Jan 1996, p 165-73. The proposed relay setting and coordination technique provides the optimum relay settings for various operating states of the power system. The developed technique has the ability to identify the infeasible conditions between the primary and back-up relays and isolate infeasible constraints.

A New Digital Directional Transverse Differential Current Protection Technique, M. M. Eissa, O. P. Malik, IEEE Trans. on Power Delivery, Vol. 11, No. 3, Jul 1996, p 1285-91. This paper discusses a proposed digital scheme for the protection of two parallel lines. This is the digital equivalent of the electromechanical current balance relay, comparing the two line currents for direction and difference.

Algorithms for Locating Faults on Series Compensated Lines Using Neural Network and Deterministic Methods, D. Novosel, B. Bachmann, D. Hart, Y. Hu, M. M. Saha, IEEE Trans. on Power Delivery, Vol. 11, No. 4, Oct 1996, p 1728-36. This paper investigates a scheme to improve the reach measurement of distance relays and fault locator for series compensated lines using a deterministic method and a feedforward neural network.

A Recursive Newton Type Algorithm for Digital Frequency Relaying, V. V. Terzija, M. B. Djuric, N. Z. Jeremic, Electric Systems Research, Vol. 36, 1996, p 67-72. This paper presents a new recursive Newton type algorithm devoted to frequency relaying.

3151 DISTRIBUTION AND NETWORK PROTECTION

3151.1 Industrial and Power Station Auxiliaries

Harmonic Filters for a New Industrial Customer, D.A. Lips, S.H. Williamson, 50th Annual Georgia Tech Protective Relaying Conference, May 1-3, 1996. Electric utilities have had to deal with an increased number of harmonic concerns over the last few years. This paper describes one utility's experience dealing with this issue with a new customer including the type of service, problem identification, and proposed solution.

3151.2 Primary Distribution Systems

Protection Scheme Grows with Customer Base, D.P. Agoris, Transmission & Distribution, Vol. 48, No. 11, Oct 96, p 42-8. Public power company of Greece uses autoreclosers, sectionalizers, fuses, and voltage regulation schemes to provide reliability to its customers.

High Impedance Fault Detection Implementation Issues, B. M. Aucoin, R. H. Jones, IEEE Trans. on Power Delivery, Vol. 11, No. 1, Jan 1996, p 139-48. This paper discusses technical and non-technical issues associated with applying high impedance fault detectors. These include: Accuracy and Security, Effect of Outages, Identification of Imminent Hazards, and Emotional Issues.

IEEE Issues High-Impedance Fault Detection Report, W. Beaty, Electric Light and Power, Vol. 74, No. 10, Oct 96, p 25 and 31. Various methods of detecting HIF (High-Impedance Faults) are discussed including use of pattern recognition, open conductor detection, falling conductor interception, and artificial intelligence.

Wavelets: A New Tool for the Resonant Grounded Power Distribution System Relaying, O. Chaari, M. Neunier, F. Brouaye, IEEE Trans. on Power Delivery, Vol. 11, No. 3, Jul 1996, p 1301-8. In a compensated distribution network, single phase faults have a low system frequency current. They are often formed by a succession of short self extinguishing faults in which the transient terms are very important. This paper introduces (fast decaying oscillations) and shows that they may be useful to analyze the transient earth fault signals.

Feeders are Automated for Increased Reliability, Brian J. Deaver Sr. and Ali Khorramshahi, Transmission & Distribution, Vol. 48, No. 6, Jun 96, p 73, 79-81. Baltimore Gas & Electric combines advances in telecommunication, electronic control, switching, and protective equipment to reduce duration of outages on its distribution circuits.

Analysis of Distribution Disturbances and Arcing Faults Using the Crest Factor, C. J. Kim, B. D. Russel, Electric Power Systems Research, Vol. 35,1995, p 141-8. Theoretical perspectives of the transients are studied and their impacts on changes in the crest factor are thoroughly examined.

Analysis of High Impedance Faults Using Fractal Techniques, A.V. Mamishev, B.D. Russell, C.L. Benner, IEEE Trans. on Power Systems, Vol. 11, No. 1, 1996, p 435-40. The concepts of fractal geometry are used to analyze chaotic properties of high impedance faults. An algorithm for pattern recognition and detection of high impedance

faults is presented. Examples are given to illustrate the new technique.

How to Use the Many New Features of Microprocessor Distribution Relays, R. Taylor, 50th Annual Georgia Tech Protective Relaying Conference, May 1-3, 1996. Modern microprocessor based devices have changed the capabilities of the protection that can be applied to feeders and have provided an array of new tools to aid in operations and post-fault analysis. This paper attempts to provide some suggestions on how users might consider taking advantage of some of the capabilities provided by these devices.

Coordination of Directional Overcurrent Relay Timing Using Linear Programming, A. J. Urdaneta, H. Restrepo, S. Marquez, J. Sanchez, IEEE Trans. on Power Delivery, Vol. 11, No. 1, Jan 1996, p 122-9. This paper discusses a program for setting directional overcurrent relays associated with a new system addition and the resetting of the minimum number of relays on the existing system. There is a tradeoff between the optimal settings of the relays and the number of existing relays to be reset.

3152 TRANSMISSION LINE PROTECTION

3152.1 Distance and Ground Relaying

Advancements in Adaptive Algorithms for Secure High Speed Distance Protection, M.G. Adamiak, G.E. Alexander, W. Premerlani, 23rd Annual Western Protective Relay Conference, Oct 15-17, 1996. Numerical transmission line distance protection systems have been widely applied in recent years primarily because of their monitoring and communications capabilities rather than for improved performance of the protection functions. This paper discusses recent developments in adaptive algorithms and the use of higher sampling rates combine to provide secure high speed protection not available with previous implementations.

Application of Phase and Ground Distance Relays to Three Terminal Lines, G.E. Alexander, J.G. Andrichak, 49th Annual Texas A&M Protective Relay Conference Apr 15-17, 1996. Presented in this paper are some of the issues related to protection of three terminal lines and it provides a tutorial for the protection engineer on some of the fundamentals of three terminal line protection. Also noted is that with today's integrated packages, the cost penalty for adding zones of protection is minimal, thereby making the protection of such lines more feasible.

Fourier and Walsh Digital Filtering Algorithms for Distance Protection, H.J. Altuve F., I. Diaz V., E. Vazquez M., IEEE Trans. on Power Systems, Vol. 11, No. 1, 1996, p 457-62. This paper presents a comparative evaluation of distance protection algorithms based on Fourier and Walsh transforms, and a recently proposed combined sine-consine filter.

Distance Relay Fundamentals, J.G. Andrichak, G.E. Alexander, 23rd Annual Western Protective Relay Conference, Oct 15-17, 1996. This paper is a tutorial which discusses the fundamental features of electromechanical, analog, and digital relays and possible problems that may have occurred in their design and application.

New Ground Directional Elements Operate Reliably for Changing System Conditions, A. Guzman, J. Roberts, D. Hou, 23rd Annual Western Protective Relay Conference, Oct 15-17, 1996. This paper describes a new ground directional relay that selects among zero-sequence current-polarized, negative-sequence voltage-polarized, or zero-sequence voltage-polarized directional elements according to system conditions.

An Adaptive Approach in Distance Protection Using an Artificial Neural Network, S. A. Khaparde, N. Warke, S. H. Agarwal, Electric Power Systems Research Vol. 37, 1996, p 39-44. This paper considers a two-terminal transmission line, confirms that fault resistance and the location of faults can produce erroneous relay function, and finally suggests ways to ensure the generation of the correct signal for relay operation.

Ground Fault Protection of Impedance Grounded Systems: A Case Study, A.P. Meliopoulas, R.I. James, Jr., J.A. Gavin, G.J. Breaux, P.J. Chamoun, 50th Annual Georgia Tech Protective Relaying Conference, May 1-3, 1996. Typical application of ground relays in impedance grounded systems is characterized with rather sensitive settings since the expected ground fault current is typically low. This paper describes three unwanted operations of these ground relays, the resulting case study, and the resulting proper setting resulting from this investigation.

New Method of Power Swing Blocking for Digital Distance Protection, P.J. Moore, A.T. Johns, IEE Proceedings-C, Vol. 143, No. 1, 1996, p 19-26. Digital relay operation is prevented by detecting transients in the measured reactance using two parallel FIR filters. Simulation results are also presented.

Application Benefits of Numerical Distance Protection, S. Pickering, 49th Annual Texas A&M Protective Relay Conference Apr 15-17, 1996. The application enhancements of numerical distance protection over static, microprocessor-based predecessors, stem from several design aspects. This paper shows how these advances will help to overcome some of the traditionally more difficult applications for distance relays.

Special Domain Arcing Fault Recognition and Fault Distance Calculation in Transmission Systems, Z. M. Radojevic, V. V. Terzija, M. B. Djuric, Electric Power Systems Research Vol. 37, 1996, p 105-13. A new numerical

algorithm for recognizing arcing faults for the purpose of automatic reclosing is presented.

Limits to the Sensitivity of Ground Directional and Distance Protection, J. Roberts, E.O. Schweitzer, R. Arora, E. Poggi, , 49th Annual Texas A&M Protective Relay Conference Apr 15-17, 1996. Sensitivity of protective relays today is generally not limited by the relays, but instead is limited by the rest of the system: system unbalance, instrument transformer accuracy and ratings, grounding practices, and source strengths. This paper identifies these limits, analyzes them, and offers practical solutions.

An Investigation into the Use of Adaptive Setting Techniques for Improved Distance Back-Up Protection, B. Stedall, P. Moore, A. Johns, J. Goody, M. Burt, IEEE Trans. on Power Delivery, Vol. 11, No. 2, Apr 1996, p 757-62. This paper describes a proposed system for the U. K. 400 kV system to adapt zone 3 settings based on system conditions. Adaptation is achieved by the use of a local impedance model at each substation which is continually updated by a hierarchical information network.

Design, Implementation and Performance Evaluation of a New Digital Distance Relaying Algorithm, D.L. Waikar, A.C. Liew, S. Elangovan, IEEE Trans. on Power Systems, Vol. 11, No. 1, 1996, p 448-56. This paper presents performance results of a digital distance relaying algorithm using data generated from a transient program and physical models of the transmission lines.

Performance of an Adaptive Protection Scheme for Series Compensated EHV Transmission Systems Using Neural Networks, Q. Y. Xuan, Y. H. Song, A. T. Johns, R. Morgan, D. Williams, Electric Power Systems Research, Vol. 36, 1996, p 57-66. This paper proposes an adaptive protection scheme based on neural networks with special emphasis on analysis of the first-zone performance.

Fault Component Reactance Relay, S. Zhu, Y. Xing, F. Sui, IEEE Trans. on Power Delivery, Vol. 11, No. 3, Jul 1996, p 1292-1300. The paper describes development of a new reactance distance relay operating on current and voltage criteria deviation signals. Performances are analyzed.

3152.2 Relay Communications

Relay-to-Relay Digital Logic Communication For Line Protection, Monitoring, and Control, K.C. Behrendt, 23rd Annual Western Protective Relay Conference, Oct 15-17, 1996. This paper discusses a new approach to achieve high-speed line protection, monitoring, and control using microprocessor-based relay-to-relay digital logic communication. Novel, cost-saving applications made possible by this new approach are also presented.

On the Upcoming Second Revolution in Protection Systems, J. Dzieduszko, 49th Annual Texas A&M Protective Relay Conference Apr 15-17, 1996. This paper discusses how the existing and developing communication technologies promote widespread use of simple, current only type, comparison protection systems.

Coding Techniques for Secure Digital Communications for Unit Protection of Distribution Feeders, M. A. Redfern, D. P. McGuinness, R. F. Ormondroyd, IEEE Trans. on Power Delivery, Vol. 11, No. 1, Apr 1996, p 716-24. This paper is based on an investigation of techniques to enhance a communication system for a digital protection scheme in which corrupted data is properly identified and the use of such data is minimized. Two coding strategies have been analyzed.

Power Line Carrier Channel and Application Considerations for Use with Transmission Line Relaying, M.P. Sanders, R.E. Ray, 50th Annual Georgia Tech Protective Relaying Conference, May 1-3, 1996. This paper is a tutorial that presents the basic principles of Power-Line Carrier to assist engineers who are new to this field as well as provide some good reference material for those experienced individuals who desire refresher information. It focuses on the application of carrier in protective relaying schemes.

Substation Communications: When Should I Use EIA-232, EIA-485, and Optical Fiber?, K. Zimmerman, E.O. Schweitzer, III, 23rd Annual Western Protective Relay Conference, Oct 15-17, 1996. This paper compares various communications with respect to speed, security, safety, network configuration, troubleshooting, and economics.

3152.3 Relay Systems

Nonunit Protection Technique for EHV Transmission Systems Based on Fault-Generated Noise. Part 3: Engineering and HV Laboratory Testing, R.K. Aggarwal, A.T. Johns, Z.Q. Bo, IEE Proceedings-C, Vol. 143, No. 3, 1996, p 276-82. This paper describes the various stages involved in the prototype hardware development and implementation of a protection scheme previously reported in the literature. Experimental setup at a HV laboratory for testing the prototype hardware is given.

Relay Protection Operation for Faults on NYSEG's Six Phase Transmission Line, A. E. Apostolov, R. G. Raffensperger, IEEE Trans. on Power Delivery, Vol. 11, No. 1, Jan 1996, p 191-6. The paper briefly describes the integration of available digital three phase relays with a programmable logic relay for six phase line protection. The operation of the system during two faults is discussed. The measured fault currents are compared with values calculated by a conventional short circuit program.

Computer-Aided Design of a New Nonunit Protection Scheme for EHV Teed Circuits, A.M. Carter, R.K. Aggarwal, A.T. Johns, Z.Q. Bo, IEE Proceedings-C, Vol. 143, No. 2, 1996, p 142-50. This paper describes digital

processing techniques for processing high-frequency voltage signals to protect teed circuits. The fundamental principles are an extension of those previously reported in the literature.

Multi Neural Network Based Fault Area Estimation for High Speed Protective Relaying, T. Dalstein, T. Friedrich, B. Kulicke, D. Sobajic, IEEE Trans. on Power Delivery, Vol. 11, No. 2, Apr 1996, p 740-7. Arcing faults, transformer saturation, power swings, etc. can cause errors in distance relay impedance measurements. Artificial neural networks have a large input error tolerance. A concept of 10 neural networks is proposed where each is trained on a particular fault type. Fault area estimation can be done in 5-12 ms.

Combined-Sequence Phase Comparison Relaying, J.W. Dzieduszko, 23rd Annual Western Protective Relay Conference, Oct 15-17, 1996. This paper provides a basic review of phase comparison relaying. It makes the point that this method of relaying may be becoming an option as the recent explosion in communication technology.

Pilot Protection of Transmission Lines: Distance-Based vs. Current-Only, W.L. Hinman, 50th Annual Georgia Tech Protective Relaying Conference, May 1-3, 1996. This paper briefly describes the fundamentals of the most commonly used pilot schemes. The relative advantages of distance-based vs. current-only schemes are outlined, history and trends discussed, and predictions of the future of pilot protection are discussed.

Exploring Transmission Relay Scheme Possibilities, J. Kraig Kahler, Transmission & Distribution, Vol. 48, No. 13, Dec 96, p 40-4. Use of 960 MHz radio proves to be most cost effective communication media for implementing a protective relay scheme to replace existing scheme using insecure copper conductors for communication.

Artificial Neural-Network-Based Protection Scheme for Controllable Series-Compensated EHV Transmission Lines, Y.H. Song, A.T. Johns, Q.Y. Xuan, IEE Proceedings-C, Vol. 143, No. 6, 1996, p 535-40. The paper proposes an adaptive protection scheme, based on neural networks, with special emphasis on analysis of zone-1 protection. System simulation and test results are presented.

Field Experience with Segregated Phase Comparison Protection System, R. Quest, J. Dzieduszko, R. Hedding, 49th Annual Texas A&M Protective Relay Conference Apr 15-17, 1996. This paper presents one utility's experience with the application of Segregated Phase Comparison Systems. It includes the selection process and describes several installations.

3153 RELAY INPUT SOURCES

Advancements in Relay Current Sensor Technology, M. Adamiak, R. Wolfs, 50th Annual Georgia Tech Protective Relaying Conference, May 1-3, 1996. New technology in the current sensing and conversion arena is now available that can provide higher accuracy than traditional magnetic current transformers over a wide dynamic range. This paper presents the theory and performance characteristics of one of these new current measurement systems.

Digital Optical Instrument Transformers Promoting New Approaches to EHV Substation Layouts, M. Adolfsson, L. Bertilsson, D. Armstrong, N. Piling, M. Bjarme, A. Jansson, J. Johansson, G. Spence, CIGRE, Aug 25-31, 1996, Paper No. 34-108. This paper describes a digital optical measuring system for EHV substations and discusses its properties and influence on substation layout.

Novel Protection and Monitoring Functions Applying Optical Current and Voltage Transducers, A. Cruden, Z. Richardson, W. Laycock, A. Bennett, J. R. McDonald, I. Andonovic, K. Brewis, CIGRE, Aug 25-31, 1996, Paper No. 34-107. This paper reviews the anticipated impact that Optical Current Transducers (OCT) and Optical Voltage Transducers (OVT) will have on the substation designs of the future.

Analyzing Polarization of Impedance Relays, A. Dierks, J. McElray, 50th Annual Georgia Tech Protective Relaying Conference, May 1-3, 1996. This paper takes a critical look at present analyzing techniques, of impedance relays that employ polarization for its accurate fault analysis, using constant current model and whether these models can correctly simulate the required fault conditions of a polarized impedance relay. The merits of analyzing a polarized impedance relay using a constant source impedance model are discussed.

Capacitive Voltage Transformers: Transient Overreach Concerns and Solutions for Distance Relaying, D. Hou, J. Roberts, 49th Annual Texas A&M Protective Relay Conference Apr 15-17, 1996. Solid-state and microprocessor relays can respond to a CVT transient due to their high operating speed and increased sensitivity. This paper discusses CVT models whose purpose is to identify which major CVT components contribute to CVT transients, reviews how Source Impedance Ratio affects the CVT transient response, and discusses improvements in relaying logic, which detects CVT transients.

The Rogowski Coil and the Voltage Divider in Power System Protection and Monitoring, P. Mähönen, M. Moisio, T. Hakola, H. Kuisti, CIGRE, Aug 25-31, 1996, Paper No. 34-103. New solutions are proposed for measuring current and voltage in power system protection and monitoring. The well-known principles of the Rogowski current sensor and the voltage divider are shown to be capable of meeting the new requirements. These sensors have become technically feasible due to the introduction of micro-processors in the secondary equipment.

The Intelligent GIS - A Fundamental Change in the Combination of Primary and Secondary Equipment, L. Schett, F. Engler, F. Jaussi, K. Pettersson, A. Kaczowski, CIGRE, Aug 25-31, 1996, Paper No. 34-104. Traditionally the high voltage part (process level) and the control and protection equipment of a substation have been treated as separate systems. This paper will illustrate the concept of the migration of the traditional borderlines between the primary and secondary equipment in GIS and discuss the resulting opportunities for both utilities and manufacturers.

Contribution of Digital Signal Processing in the Field of Current Transformers, E. Thuries, J. P. Dupraz, C. Baudart, J. P. Gris, CIGRE, Aug 25-31, 1996, Paper No. 34-110. Conventional current transformers possess many qualities due to their simplicity. However, the technological innovations now underway in the field of switchgear and substation control systems tend to underline their drawbacks. New technologies must be developed to provide users with better service quality in terms of precision, operating safety, and interoperability.

Selecting CTs to Optimize Relay Performance, S.E. Zocholl, J. Roberts, G. Benmouyal, 23rd Annual Western Protective Relay Conference, Oct 15-17, 1996. Although there is great interest in the application of current transformers for relaying, few written rules exist for selecting ratings. This paper examines the effects of saturation on various elements, and gives application guidelines that eliminate or minimize the risk of ct saturation.

3154 ROTATING MACHINERY PROTECTION

Installation of a 135 MVA NUG on the PP&L System, D.L. Bassett, 50th Annual Georgia Tech Protective Relaying Conference, May 1-3, 1996. This paper discusses one utility's experiences with integrating a large non- utility generator into their system. The relaying used for this application is described with operation history discussed.

IPP Intertie Protection, C.M. Dalton, 49th Annual Texas A&M Protective Relay Conference Apr 15-17, 1996. This paper provides a tutorial of some of the issues related to the protection of non-utility generation. Included are: background information, IPP interface considerations, protection requirements, applications and conclusions.

Numerical Generator Protection, A. Kazemi, F. Oliveira, H. Meier, 50th Annual Georgia Tech Protective Relaying Conference, May 1-3, 1996. This paper examines the advantages of numerical technology as it relates to generator protection. A multi-function protection system is described and a number of generator protection functions are examined in detail. The self-supervision feature as it relates to the protection system availability and the future maintenance requirements is discussed.

Innovations in Machine Diagnostics, G. Kliman, W. Premerlani, M. Adamiak, T. Breen, J. Dougherty, 49th Annual Texas A&M Protective Relay Conference Apr 15-17, 1996. Breakthroughs have been made utilizing a variety of methods which can be applied on today's cost effective microprocessor hardware to accurately diagnose impending failure of motors and generators. This paper describes the research, methodology, and application of this technology.

Upgrading Generator Protection Using Digital Technology, C.J. Mozina, 49th Annual Texas A&M Protective Relay Conference Apr 15-17, 1996. There are a number of functional protection areas on older generators which have significant shortcomings. This paper discusses some of the reasons why utilities should consider upgrading older generator protection schemes in order to maximize the effectiveness of their protective schemes.

Pole Slipping Protection: Problems and Solutions, M.A. Redfern, M.J. Checksfield, J.P. Gosalia, G.K. Clough, 23rd Annual Western Protective Relay Conference, Oct 15-17-1996. This paper presents a power based technique for detecting pole slipping which may have applications on non-utility generators. Also described are field tests of the relay on small units.

A Digital Technique for Stator Winding Protection of Synchronous Generators, T. S. Sidhu, B. Sunga, M. S. Sachdev, Electric Power Systems Research Vol. 36, 1996, p 45-55. This paper describes a digital technique for detecting internal faults in stator windings of synchronous generators.

3155 OTHER PROTECTION

3155.1 Transformer and Reactor Protection

An Expert System for Designing the Protection System of a Power Transformer, Liu Lifeng, Gao Zhongde, Yang Qixun, Bai Zhongmin, Electric Power Systems Research, Vol. 35,1995, p 59-64. This paper proposes an expert system for designing the protection system of a transformer by making use of a support tool, OPS83, with a graphical menu and a friendly interface.

Transformer Modeling as Applied to Differential Protection, S.E. Zocholl, A. Guzman, D. Hou, 49th Annual Texas A&M Protective Relay Conference Apr 15-17, 1996. This paper presents a power transformer model to evaluate differential element performance. The paper analyzes transformer energization, overexitation, external fault, and internal fault conditions with the model. The paper is validated with actual test results and includes a guide for properly selecting current transformers for differential protection applications.

3155.2 Capacitor Bank and Static Var Protection

Bridge Capacitor Bank Design and Operation, R. G. Andrei, R. R. Kaushik, R. W. Reinaher, IEEE Trans. on Power

Delivery, Vol. 11, No. 1, Jan 1996, p 227-33. The paper addresses the aspects related to the design and installation of a bridge capacitor bank between the 138kV and 69kV substation buses, including relay protection and control. The bridge capacitor bank is operated in conjunction with a 69 kV shunt capacitor bank, and in parallel with an auto-transformer.

Breaker-Driven Requirements for a 138 kV Shunt Capacitor Installation, R.G. Colclaser, Jr., K.A. Donohoo, Y. Yamashita, 49th Annual Texas A&M Protective Relay Conference Apr 15-17, 1996. Capacitor banks subject breakers to transient inrush currents, back-to-back transient currents, and outrush currents during faults. Control of these transients for high voltage applications can be achieved with series reactors. This paper summarizes these concepts and provides guidance for the protection engineer.

3155.3 Other Protection

Global Digital Bus Protection Overcomes CT Constraints, J.G. Andrichak, J. Cardenas, 49th Annual Texas A&M Protective Relay Conference Apr 15-17, 1996. A variety of methods have been used to implement bus differential relaying schemes. The introduction of digital technology has led to further improvements in bus differential protection. This paper reviews these various methods and discusses improvements that can be provided via digital technology.

PC Based Protective Relaying Algorithms for Bus Bars Using Digital Filters, A. M. Basha, P. Janardhanan, M. Muraleedharan, Electric Power Systems Research Vol. 36, 1996, p 169-73. The paper reports the development of protective relaying algorithms for bus bars using digital filters.

Future-Oriented Concepts for Substation Protection and Control, V. Biewendt, W. Ebbinghaus, R. Wiegand, ABB Review, 3/96, p 18-23. Sensors, digital switchgear controls, and advanced protection and control software are creating a new platform for substation secondary technology and providing many benefits.

Continuous Self-Supervision Enhances Reliability of HV Substation Protection, B. Eschermann, P. Terwiesch, K. Scherrer, ABB Review, 2/96, p 18-24. This paper describes the bus-bar protection system, REB 500, and discusses its features that include self-supervision and instant failure diagnosis and containment.

Microprocessor Based Inverse-Time Multiple Overcurrent Relays, F. Fadul, R. Krahe, Electric Power Systems Research, Vol. 35, 1995, p 207-11. In this paper, it is shown that several independent overcurrent relays and other tasks can be implemented using a single microcontroller.

Adirondack 230 kV Substation Outage of July 1, 1995, M.A. Ibrahim, F. Stacom, 50th Annual Georgia Tech Protective Relaying Conference, May 1-3, 1996. This paper describes the substation protection systems and the events and phenomena which led to the complete isolation of the 230/115-kV substation for a 230-kV line fault.

Frequency Relaying Based on Instantaneous Frequency Measurement, P. J. Moore, J. H. Allmeling, A. T. Johns, IEEE Trans. on Power Delivery, Vol. 11, No. 4, Oct 1996, p 1737-42. This paper discusses a frequency relay capable of under/over frequency and rate of change of frequency measurements implemented on a digital signal processor using an instantaneous frequency measuring algorithm.

Disturbance Recorders Trigger Detection and Protection, R. Jay Murphy, IEEE Computer Application in Power, Vol. 9, No. 1, Jan 96, p 24-8. The accurate detection of system anomalies may lead to corrective action prior to system failure, and software-based triggers enable the recording of such phenomena.

An Innovative Method of Providing Total Breaker Failure Protection, N.T. Stringer, D. Waser, IEEE Trans. on Industry Applications, Vol. 32, No. 5, 1996, p 1011-6. This paper discusses a new and innovative method of protecting a circuit breaker from the failures detected by conventional methods plus other failures that go undetected with conventional schemes thus providing "total" breaker failure protection.

Integrated Protection, Control and Data Acquisition in Substations, L. Swartz, J. C. Melcher, CIGRE, Aug 25-31, 1996, Paper No. 34-109. A project is underway in North America with the goal to achieve interoperability of Intelligent Electronic Devices (IEDs) in substations from different manufacturers. To achieve this, agreement is needed on the communication links and protocols that constitute the network between these devices. This effort is sponsored by EPRI with membership worldwide.

Admittance Relay Helps Wash Out System Instability, George Sweezy, Glenn Swift, Zhiying Zhang, IEEE Computer Application in Power, Vol. 9, No. 1, Jan 96, p 48-52. The Delta-current admittance relay detects severe power system disturbances and initiates a power reduction signal on the D.C. transmission system.

Applications of Coordinated Control, Protection and Operation Support System in EHV Substations, K. Yanagihashi, T. Furuta, K. Kawata, Y. Sano, S. Azuma, I. Mitani, CIGRE, Aug 25-31, 1996, Paper No. 34-105. This paper presents application experience with coordinated control, protection, and operation support systems in the EHV substations of three utilities.

3156 FAULT AND SYSTEM CALCULATIONS

Evaluation of a Phasor-Based Fault Location Algorithm, G.E. Alexander, J.M. Kennedy, 49th Annual Texas A&M Protective Relay Conference Apr 15-17, 1996. Fault location

calculations based on quantities from a single line terminal are subject to errors that can not be completely eliminated by settings in the algorithm. This paper discusses how improvements can be seen when currents from other lines and/or from other terminals are used in the calculation.

Automated Transmission Line Fault Analysis Using Synchronized Sampling at Two Ends, M. Kezunovic, B. Perunicic, IEEE Trans. on Power Systems, Vol. 11, No. 1, 1996, p 441-7. Synchronized samples from both ends of the line are used for fault analysis functions such as fault detection, classification, and location. EMTP simulation results are used to validate the proposed technique.

GPS Traveling Wave Fault Locator Systems: Investigation into the Anomalous Measurements Related to Lightning Strikes, H. Lee, A. M. Mousa, IEEE Trans. on Power Delivery, Vol. 11, No. 3, Jul 1996, p 1214-23. The fault location is determined by time-tagging the arrival of the traveling wave at each end and comparing the time difference to the total line propagation time. The scheme is unaffected by load, high grounding resistance, or series capacitors.

New Method of Fault Location on Double Circuit Two-Terminal Transmission Lines, A. J. Mazon, J. F. Minambres, M. A. Zorrozua, I. Zamora, R. Alvarez-Isasi, Electric Power Systems Research, Vol. 35, 1995, p 213-9. A new method to locate faults on double-circuit transmission lines is described in this paper.

A New Technique, Based on Voltages, for Fault Location on Three-Terminal Transmission Lines, J. F. Minambres, I. Zamora, a. J. Mazon, M. A. Zorrozua, R. Alvarez-Isasi, Electric Power Systems Research Vol. 37, 1996, p 143-151. A new method for fault location on three-terminal transmission lines is described in this paper.

Unsynchronized Two-Terminal Fault Location Estimation, D. Novosel, D. G. Hart, E. Udren, J. Garrity, IEEE Trans. on Power Delivery, Vol. 11, No. 1, Jan 1996, p130-8. A technique which uses data from both ends of the transmission line, but not synchronized, is described. Fault type, fault resistance, load currents, and source impedances are not needed.

Line Monitoring and Fault Location Using Spread Spectrum on Power Line Carrier, V. Taylor, M. Faulkner, IEE Proceedings-C, Vol. 143, No. 5, 1996, p 427-34. Signals transmitted over the power line carrier system are used to locate faults and other impedance mismatches on EHV transmission lines. Prototype hardware and on-line results are presented for a 225 km, 330 kV line.

New Methods for Using Relay Data to Locate Faults, E. Udren, D. Novosel, 49th Annual Texas A&M Protective Relay Conference Apr 15-17, 1996. This paper discusses application and problems of fault location, and presents new calculation methods of improved accuracy. Both single-ended and two-ended methods are presented.

A New Single-Ended Fault Locator Algorithm for Greater Accuracy, R. Whittard, A.T. Johns, J.P. Gosalia, 23rd Annual Western Protective Relay Conference, Oct 15-17, 1996. This paper presents a new, accurate single-ended, fault location algorithm which is insensitive to inaccuracies in the remote source parameter settings. This method has the potential to overcome the problems presented by unknown remote source parameters.

A New Single Ended Fault Locator Algorithm, R. Whittard, S. Turner, 49th Annual Texas A&M Protective Relay Conference Apr 15-17, 1996. This paper presents a new single-ended fault location algorithm which is insensitive to inaccuracies in the remote source parameter settings; and therefore overcomes the problems presented by unknown remote source parameters, one of the major problems presented to single-ended algorithms.

Fault Location on Two-Terminal Transmission Lines Based on Voltages, I. Zamora, J.F. Minambres, A.J. Mazon, R. Alvarez-Isasi, J. Lazaro, IEE Proceedings-C, Vol. 143, No. 1, 1996, p 1-6. The fault location method proposed in this paper is based on fundamental component of pre- and post-fault voltages measured at two ends of a transmission line. The methodology allows establishment of a direct calculation procedure that is independent of currents, fault type, fault resistance and synchronization condition at line ends.

3157 MAINTENANCE, TESTING, ANALYSIS, AND MODELING

Digital Simulators Expedite Relay Performance Evaluation, Mark G. Adamiak, Suparna G. Saldanha, IEEE Computer Application in Power, Vol. 2, No. 2, Apr 96, p 18-22. Digital simulators present a new development tool for real-time simulation techniques and automation of protective relay testing.

Use of Preventive Maintenance and System Performance Data to Optimize Scheduled Maintenance Intervals, H. Anderson, R. Loughlin, J. Zipp, 49th Annual Texas A&M Protective Relay Conference Apr 15-17, 1996. This paper describes one utility's use of protective relay system information to maximize the effectiveness of their relay maintenance program.

High Impedance Fault Detection Tester, V. L. Bucholz, M. Nagpal, J. B. Neilson, R. Parsi-Feraidoonian, W. Zarecki, IEEE Trans. on Power Delivery, Vol. 11, No. 1, Jan 1996, p 184-90. Relays are becoming available to detect HIFs by distinguishing the signatures of high impedance arcing faults. Successful testing of these relays requires the playback of recorded waveforms from a library of field

recordings of HIFs and feeder loads. A test protocol evaluates both dependability and security from false alarms.

A Study of Estimation Techniques for Frequency-Relaying Applications, M.E. El-Hawary, M.A. Mostafa, A.M. El-Arabaty, M.M. Mansour, K.M. El-Naggar, Canadian Journal of Elec. and Comp. Eng., Vol. 21, No. 1, 1996, p 9-20. This paper presents an evaluation and performance comparison of least error squares and least absolute value algorithms for frequency estimation.

ATP Simulator Test of Low Impedance Bus Differential Protection, J. Esztergalyos, J.P. Gosalia, S.P. Turner, R. Ryan, 23rd Annual Western Protective Relay Conference, Oct 15-17, 1996. From the view of power system stability, a reliable and secure high speed bus fault protection is critical. This paper describes a new bus differential relay system including the use of the Alternate Transient Program on how to create bus fault cases for relay testing, and the laboratory testing of the new bus differential relay on a digital simulator.

Transient Modeling of Electromechanical Relays, Part 1: Armature Type Overcurrent Relays, Part 2: Plunger Type 50 Relays, M. T. Glinkowski, J. Esztergalyos, IEEE Trans. on Power Delivery, Vol. 11, No. 2, Apr 1996, Part 1 p 763-70, Part 2 p 771-82. These two papers describe the developments of EMTP/ATP models of electromechanical overcurrent relays. Mechanical and magnetic properties are modeled by mathematical equations of motion and magnetic force. Performance is affected by dc offset and CT and relay saturation.

The Protection System Index: One Utility's Experience, D. Goodrich, 23rd Annual Western Protective Relay Conference, Oct 15-17, 1996. This paper describes the process of keeping a protection performance index. The paper explains how a protection system performance index was developed, and how the utility adapted the published indices to its distribution system, and the benefits thereof.

The Value of Detail Mutual Impedance Modeling, J. Hanson, J. Dahnke, 49th Annual Texas A&M Protective Relay Conference Apr 15-17, 1996. Failure to properly account for the effects of mutual coupling can result in the interruption of service to customers. This paper discusses one utility's experience related to this problem.

The Effects of GIC on Protective Relaying, IEEE Power System Relaying Committee Report, IEEE Trans. on Power Delivery, Vol. 11, No. 2, Apr 1996, p 725-39. Of 120 major magnetic storms in the 1989-1991 period, at least 14 resulted in protective relay operation. This report summarizes these incidents and gives revised operating policies of utilities affected. It includes a guide to relay engineers on how to recognize the hazards, and recommendations.

Design, Implementation, and Validation of a Real-Time Digital Simulator for Protective Relay Testing, M. Kezunovic, J. Domaszewicz, Z. Skendzic, M. Aganagic, J. K. Bladow, S. M. McKenna, D. M. Hamai, IEEE Trans. on Power Delivery, Vol. 11, No. 1, Jan 1996, p 158-64. This paper reports on a new approach to real-time simulator implementation using a single processor computer for network simulation and multiple digital signal processors for instrument transformer and circuit breaker modeling. Three independent test terminals are available.

Advanced Testing Methods for Protective Relays Using New Digital Simulator Designs, M. Kezunovic, C. W. Fromen, D. R. Sevicik, S. M. McKenna, B. Pickett, N. Izquierdo, CIGRE, Aug 25-31, 1996, Paper No. 34-204. This paper discusses new testing methods as means of improving the performance of the protection system. Present test practices and existing limitations of the standard test equipment are outlined. New developments of digital simulators are mentioned to indicate their enhanced capability when compared to the standard test equipment.

An Advanced Method for Testing of Distance Relay Operating Characteristic, M. Kezunovic, Y. Q. Xia, Y. Guo, C. W. Fromen, R.D. Sevcik, IEEE Trans. on Power Delivery, Vol. 11, No. 1, Jan 1996, p 149-57. In this paper, prefault and fault signals for single-line-to-ground, double-line-to-ground, line-to-line, and three-phase faults are derived from symmetrical component fault analysis. The phasor based test method uses just the fundamental frequency test signals but simulates a fault by instantaneously switching between prefault, fault, and postfault states.

Configuration and Integration of Substation Secondary Equipment, C. G. A. Koreman, M. Kezunovic, S. Lemmer, A. Newbould, CIGRE, Aug 25-31, 1996, Paper No. 34-106. Modern substation secondary system design is becoming increasingly based on a smaller number of integrated multi-functional digital equipments. This paper examines those factors that will influence the future configuration of the complete secondary system of EHV and HV substations, including: Management of assets. Reliability and maintenance. Advances in digital technology. Serial data communications and information technology. Changes in the electricity market.

GPS Satellite Synchronized Test Systems Recreate Fault Conditions to Troubleshoot Protective Relay Schemes, M. Lillian, S.I. Thompson, 23rd Annual Western Protective Relay Conference, Oct 15-17, 1996. This paper presents one utility's experience using GPS satellite synchronized test system to recreate a relay system misoperation. The paper highlights the detective work required to successfully identify the problem.

Experience of REE with Digital Control Systems (DCS), J. M. Lopez Fernandez, CIGRE, Aug 25-31, 1996, Paper No.

34-102. This document describes the experience of Red Eléctrica de España (REE) with the Digital Control Systems (DCS) that the company is installing in the new substations of the Spanish Transport Network and in those substations that need deep renewal and improvement.

A General Method to Determine the Characteristics and Operating Regions of Distance Relays in Z-Plane, C.C. Maican, Canadian Journal of Elec. and Comp. Eng., Vol. 21, No. 1, 1996, p 21-8. A general method, using theory of functions of a complex variable Z, for determining the characteristics and operating regions of directional and distance relays in the Z-plane is described.

Decision Support for the Interpretation of Power Network Data of Relevance to Protection Engineers, S. D. J. McArthur, S. C. Bell, R. Mather, S. M. Burt, J. R. McDonald, T. Cumming, CIGRE, Aug 25-31, 1996, Paper No. 34-203. Power system protection performance is analyzed by using SCADA system data and then any relevant fault records. This process may be problematic following extreme conditions whereby extensive SCADA system alarms were generated. This paper reports on a decision support system (DSS) which utilizes both knowledge based and model based techniques to provide such a facility for utility protection engineers.

The Application of Model Based Reasoning Within a Decision Support System for Protection Engineers, S. D. J. McArthur, A. Dysko, J. R. McDonalds, S. C. Bell, R. Mather, S. M. Burt, IEEE Trans. on Power Delivery, Vol. 11, No. 4, Oct 1996, p 1748-54. This paper discusses appropriate modeling and reasoning methodologies and their advantages when applied to protection system performance analysis.

Advanced Features of the Integrated Protection and Control System in Ontario Hydro Substations, B. C. Mitchell, CIGRE, Aug 25-31, 1996, Paper No. 34-101. A fully integrated protection and control system developed for implementation in Ontario Hydro substations uniquely combines digital signal processing techniques with knowledge-based process control software to achieve important substation life cycle cost reductions.

Reliability of Protective Apparatus and its Impact on Power System Performance, I. Patriota De Sequeira, CIGRE, Aug 25-31, 1996, Paper No. 34-201. Decision support aids, based on performability and quality indexes, are defined, correlating protection reliability to traditional benchmarkings of power system. Markov chains are used to model protective systems, measuring the impact of reliability and maintenance policy on power system performance.

A Laboratory for Research and Teaching of Microprocessor-Based Power System Protection, M.S. Sachdev, T.S. Sidhu, IEEE trans. on Power Systems, Vol. 11, No. 2, 1996, p 613-19. The paper describes the facilities of a laboratory and their functions for conducting research and teaching in the area of power system protection.

Statistical Comparison and Evaluation of Pilot Protection Schemes, E.O. Schweitzer, III, J.J. Kumm, 23rd Annual Western Protective Relay Conference, Oct 15-17, 1996. This paper analyzes several variables in the overall dependability and security of various pilot systems. It also proposes a new scheme, which provides faster operation, better fault resistance coverage, and minimizes risks of mis-operation.

Improving Breaker TRV with EMTP Studies, H.M. Shuh, G.L. Kobet, 50th Annual Georgia Tech Protective Relaying Conference, May 1-3, 1996. This paper describes one utility's use of EMTP to review equipment of an existing 13-kV substation in which breaker ratings was a concern. The paper describes the EMTP studies for this situation and illustrates the results of these studies and the resulting improvement in the protection.

Dynamic Testing of Frequency Relays, N.T. Stringer, IEEE Trans. on Industry Applications, Vol. 32, No. 4, 1996, p 766-77. This paper discusses the intricacies of dynamic frequency testing including test equipment and frequency relays. Results from testing of four different frequency relays are reported.

Coordinating Overcurrent Protection Devices, Matthew St. John and Alberto Borgnino, IEEE Computer Application in Power, Vol. 9, No. 3, Jul 96, p 41-4. System-wide coordination can be checked more easily, a critical need for maintaining high reliability margins. Accurately coordinating overcurrent protective devices minimizes or prevents equipment damage and improves power service to customers. A comprehensive TCC data is stored in point and equation form, and program can organize and maintain the data for the most settable overcurrent devices on a distribution system. An overcurrent protection program is an excellent training tool for inexperienced engineers.

Anatomy of Power System Blackouts: Preventive Relaying Strategies, S. Tamronglak, S. H. Horowitz, A.G. Phadke, J. S. Thorp, IEEE Trans. on Power Delivery, Vol. 11, No. 2, Apr 1996, p 708-15. The analysis of major system disturbances indicate that hidden relay defects can be a major factor causing otherwise routine relay operations to develop into widespread outages. With the knowledge of which relays are most vulnerable, counter measures can be taken to reduce the likelihood of the hidden failure of key relays.

Statistical Performance Measures for Protective Relays, E.A. Udren, 23rd Annual Western Protective Relay Conference, Oct 15-17, 1996. This paper summarizes the work of an IEEE Working Group for measuring the performance of protective relaying systems. The paper shows how to

calculate mean time before failure and categorizes misoperations and relay system failures.

Verification of Measured Transmission System Phase Angles, R. E. Wilson, P. S. Sterlina, IEEE Trans. on Power Delivery, Vol. 11, No. 4, Oct 1996, p 1743-47. This paper compares phase angles measured by a synchronized measuring unit during field testing of classical theory.

Fundamental Considerations on User-Configurable Multifunctional Numerical Protection, W. Wimmer, W. Fromm, P. Müller F. Ilar, CIGRE, Aug 25-31, 1996, Paper No. 34-202. In the case of microprocessor-based protection devices, the protection functions are implemented in the software. The user thus has the possibility of configuring the same piece of hardware to perform different protection functions, something quite out of the question with conventional protection devices.

A Windows Based GUI Software Tool for System Protection Simulations in PC Environment, D C. Yr, S. Ramasamy, P. Tang, N. Gang, D. Chen, H. Tang, D. G. Flinn, , IEEE Trans. on Power Delivery, Vol. 11, No. 4, Oct 1996, p 1720-27. This paper presents a Graphical Window based software tool to facilitate the analysis and training of system protection personnel.

3158 STABILITY, OUT OF STEP, RESTORATION

Some Thoughts on Single-Pole Tripping, W.A. Elmore, 49th Annual Texas A&M Protective Relay Conference Apr 15-17, 1996. This paper presents a thorough tutorial on the subject of single pole tripping. Discussed are: stability advantages, phase selection methods, subsequent fault identification, symmetrical component representation, influence on rotating machinery, and the future increased use of this philosophy.

Design and Implementation of an Adaptive Single Pole Autoclosure Technique for Transmission Lines Using Artificial Neural Networks, D. S. Fitton, R. W. Dunn, R. K. Aggarwal, A. T. Johns, A. Bennett, IEEE Trans. on Power Delivery, Vol. 11, No. 2, Apr 1996, p 748-56. Adaptive single pole autoreclosure offers increased rate of successful reclosure, improved system stability, and reduced system and equipment shock for a permanent fault. This paper describes developments in the analysis, design, and implementation of an adaptive system using ANNs.

Generator Synchronizing-Industry Survey Results, IEEE Power System Relaying Committee Report, IEEE Trans. on Power Delivery, Vol. 11, No. 1, Jan 1996, p 174-83. The survey collected data on four specific aspects: 1. General description of plant installations and reason for selecting the method of synchronizing, 2. Data for the most recent application, 3. Settings and calculations, and 4. Scheme performance. The results are discussed.

3159 SURGE PHENOMENA

Summary of IEEE Standard C37.90.2-1995 - Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers, IEEE Power System Relaying Committee Report, IEEE Trans. on Power Delivery, Vol. 11, No. 1, Jul 1996, p 1263-5. This paper describes the experience with the trial use standard ANSI/IEEE C37.90.2-1987 and the changes that have been made to the trial use standard before the 1995 standard was approved.

LIST OF PERIODICALS

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