BIBLIOGRAPHY OF RELAY LITERATURE, 1991
IEEE COMMITTEE REPORT

Members of the Bibliography and Publicity Working Group of the IEEE Power System Relaying Committee are: M.S. Sachdev, Chairman, A.G. Folkman, J.W. Ingleson, M. Kezunovic, R. Ramaswami, T.S. Sidhu, J.E. Stephens, M.J. Swanson and P.B. Winston

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 for	Volume	Particulars of Transaction 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

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:

92 SM 385-5 PWRD A paper recommended and approved by the IEEE Power System Relaying Committee of the IEEE Power Engineering Society for presentation at the IEEE/PES 1992 Summer Meeting, Seattle, WA, July 12-16, 1992. Manuscript submitted March 25, 1992; made available for printing April 6, 1992.

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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 all countries are covered.

3150 RELAYING ALGORITHMS

An Investigation into a Method of Detecting the Fault Induced High Frequency Voltage Signals of EHV Transmission Lines for Protection Applications, P. Agrawal, IEEE Trans. on Power Delivery, Vol. 6, No. 1, 1991, p 119-26. The paper investigates a method of detecting fault induced RF signals in a particular frequency band width in the kilo Hertz range. Responses of different frequency band widths and different fault inception angles have been studied and their relationship described.

Performance of the Pramod Scheme for UHS Protection of EHV Transmission Lines Under Arcing Fault Conditions, P. Agrawal, IEEE Trans. on Power Delivery, Vol. 6, No. 1, 1991, p 127-34. The scheme is based on detecting high frequency components of fault generated noise. The arcing fault has been found to generate a significant high frequency component which repeats every half cycle, even at zero voltage fault inception.

Programmable Controllers Used in Substations are Flexible, Low Cost and Efficient, M.F. Best, Transmission & Distribution, Vol. 43, No. 3, 1991, p 52-6. The use of Programmable Logic Controllers (PLC) allows an electric utility engineer to design efficient, low cost and flexible relay and control systems. If PLC's achieve faster speeds, they may be used in high speed protective relay schemes.

Recursive Real-Time Calculation of Basic Waveforms of Signals, K. Eichhorn and T. Lobos, IEE Proceedings-C, Vol. 138, No. 6, 1991, p 469-70. A recursive implementation of methods based on the Fourier technique and used for real-time estimation of the basic parameters of signals is presented. Recursive algorithms have same properties as non-recursive algorithms but they require fewer calculations.

Digital Relays are Used in Transmission & Subtransmission, D. Haas and G. Smith, Transmission & Distribution, Vol. 43, No. 3, 1991, p 66-9. Benefits of digital relays, such as scheme flexibility, implementation costs, and compact size are discussed. The paper also outlines their applications to sub-transmission and transmission system protection.

The Impact of Microprocessor Protective Relays in the Electric Utility Industry, K.W. Jeffers, Transmission & Distribution, Vol. 43, No. 8, 1991. The background history of microprocessor based relays is described and their versatility and space saving benefits are outlined.

Modal Kalman Filtering Based Impedance Relaying, J.L. Pinto de Sa and L. Pedro, IEEE Trans. on Power Delivery, Vol. 6, No. 1, 1991, p 78-84. The paper reports on the investigation of a relaying algorithm to yield an impedance estimate. The nature of noise on a 400 kV line was investigated and used in the filter evaluation.

A Recursive Least Squares Algorithm for Power System Relaying and Measurement Applications, M.S. Sachdev and M. Nagpal, IEEE Trans. on Power Delivery, Vol. 6, No. 3, 1991, p 1008-15. A non-recursive function depends on a current input but a recursive function depends on the present input and all previous inputs. This paper describes a procedure for converting a non-recursive least error squares filter to a recursive least squares filter. The development of the recursive least squares filters, using input models containing harmonic components to reduce output errors, is also illustrated.

A High Speed Power System Transmission Line Protection Scheme Using a 32-bit Microprocessor, Y.F. Wang and A.H.M.S. Ula, Electric Power Systems Research, Vol. 21, 1991, p 195-202. This paper develops a digital protection scheme for transmission lines. The method used analyzes the power spectrum of the transient fault currents and is implemented on a 32-bit MVME133 mono-board microcomputer.

3151 DISTRIBUTION AND NETWORK PROTECTION

3151.1 Industrial and Power Station Auxiliaries

The Design of a Microprocessor-Based Relay for Ground Fault Protection - Part I, A. Gangopadhyay, Trans. CEA E&O Div., Vol. 30, 1991, Paper No. 91-SP-159. The design of a microprocessor based ground fault relay is described. The formulation of the algorithm and calculation of the peak value from the SAL and CAL coefficients is discussed. A method for computing time-current characteristics is also outlined. Achieving selectivity by using zone selective instantaneous protection is described in the paper.

The Design of a Microprocessor-Based Relay for Ground Fault Protection - Part II, A. Gangopadhyay, CEA E&O Div., Vol. 30, 1991, Paper No. 91-SP-160. The design of a ground fault relay based on a microcontroller is described in this paper. Design considerations and hardware aspects are discussed. Tests recommended by different relay standards are also examined.

Bus Transfer Practices at Nuclear Plants, S. Mazumdar and M. Chiramal, IEEE Trans. on Power Delivery, Vol. 6, No. 4, 1991, p 1438-43. The paper notes that from 1985 to 1989, 50 bus transfers have failed. The paper discusses the various methods used, ways to reduce the need for transfers, and methods to increase the speed of transfer and to minimize motor transients.

3151.2 Primary Distribution Systems

Computer-Aided Protection System Design with Reconfiguration, R.P. Broadwater, J.C. Thompson, R.E. Lee and H. Maghdan-D, IEEE Trans. on Power Delivery, Vol. 6, No. 1, 1991, p 260-6. A computer-aided protection system design algorithm for radial distribution systems with automatic switches is presented. A set of design rules for coordination, placement, and selection of protective devices are developed. Eleven data base tables are used. A design example is included.

Improved Sensitivity and Security for Distribution Bus and Feeder Relays, A.F. Elneweihi and E.O. Schweitzer, III, 18th Annual Western Protective Relay Conference, Oct. 22-24, 1991. This paper presents two new relays for distribution bus and feeder protection which improve phase fault sensitivity with no loss of security. They also offer great flexibility in protection scheme design.

Protective Device Coordination Expert System, H.W. Hong, C-T. Sun, V.M. Mesa and S. Ng, IEEE Trans. on Power Delivery, Vol. 6, No. 1, 1991, p 359-65. This paper discusses a procedure to evaluate distribution circuit protective device miscoordination, suggests remedies and identifies the most appropriate corrective action. The program covers relays, fuses, reclosers, and interrupters.

A Practical Protective Relay for Down-Conductor Faults, D.I. Jeerings and J.R. Linders, IEEE Trans. on Power Delivery, Vol. 6, No. 2, 1991, p 565-74. The use of the 3rd harmonic current magnitude and the phase relationship to the system voltage is shown to be suitable for detecting high impedance ground faults. The relay reliability is enhanced by the directional measurement of current and by monitoring the ratio of the harmonics observed.

New Approach to Directional Fault Location for Overhead Power Distribution Feeders, A.T. Johns, L.L. Lai, M. El-Hami and D.J. Daruvala, IEE Proceedings-C, Vol. 138, No. 4, 1991, p 351-7. A method based on detection of fault induced high frequency components to localise faults in overhead transmission lines is presented in this paper. The method detects low-level breakdown of insulators and the direction of the fault. Simulation results are included to illustrate the

performance of the proposed method.

A Learning Method for Use in Intelligent Computer Relays for High Impedance Faults, C.J. Kim and B.D. Russell, IEEE Trans. on Power Delivery, Vol. 6, No. 1, 1991, p 109-15. The paper discusses the development of a system using inductive reasoning for pattern classification. An intelligent detection system successfully learns about the system and its parameters, identifies the data which the controller uses to make decisions, and stores the identified data. An induction process then updates the rules to change the behaviour of the detection system.

High Impedance Fault Detection Utilizing Incremental Variance of Normalized Even Order Harmonic Power, W.K. Kwon, G.W. Lee, Y.M. Park, M.C. Yoon and M.Y. Yoo, IEEE Trans. on Power Delivery, Vol. 6, No. 2, 1991, p 557-64. The proposed scheme makes use of the even and odd harmonic energy powers during a fault. Detection of a high impedance fault is made when three criteria exceed threshold values. The criteria are based on even order harmonic power, the ratio of even order to odd order harmonic powers, and the even order power variance. One hundred field tests have been conducted over three years.

Optimal Arcing Fault Detection Using Signal Processing Techniques, S. Li and B.D. Russell, Electric Power Systems Research, Vol. 21, 1991, p 128-31. An application of classical detection theory for detecting high impedance faults in electric power systems is presented. The optimal fault detector which monitors power can be realized using a digital notch filter and a sliding sum of the squared outputs of the filter.

Rule-Based Coordination Program Evaluates Distribution Transformer Overcurrent Protection Alternatives, S.R. Mendis, M.T. Bishop and D.A. Gonzalez, IEEE Computer Applications in Power, Vol. 4, No. 2, 1991, p 31-6. V-PRO is a pc based coordination program with which a distribution engineer can evaluate readily different protection schemes. It has an extensive library of time co-ordinatioin curves of protective devices, customized macros and an expert system module.

Computer Relaying and Expert Systems: New Tools for Detecting High Impedance Faults, B.D. Russell, Electric Power Systems Research, Vol. 20, 1990, p 31-37. This paper presents newly developed methods for detecting high impedance, low current faults using signal processing and pattern recognition techniques with the aid of expert systems. Fault detection parameters are identified and algorithms suitable for use in microprocessor based relays are presented.

3152 TRANSMISSION LINE PROTECTION

3152.1 Distance and Ground Relaying

Relaying Short Lines, G.E. Alexander, J.G. Andrichak and W.Z. Tyska, Texas A&M Protective Relaying Conference, Apr. 15-17, 1991. Presented is a brief overview of some of the advantages and disadvantages of both current only schemes and distance/directional schemes for protecting short lines. Also discussed are some of the problems that arise as the source to line impedance ratio increases.

Ground Relay Coordination Using a PC Automated Software Program, M.E. Berry, M.H. Cooper and R. Henson, 45th Annual Ga. Tech Protective Relaying Conference, May 1-3, 1991. The coordination of ground relays often requires many iterations of coordination calculations in order to achieve satisfactory results. This paper describes one utility's experience with a software program for solving this problem.

An Adaptive Approach in Digital Distance Protection, Z. Zhizhe and C. Deshu, IEEE Trans. on Power Delivery, Vol. 6, No. 1, 1991, p 135-42. Application of some adaptive methods is described. The basic rules and techniques are outlined. Adaptive methods, aimed at three problems, discussed in the paper deal with the effect of frequency variation, the effect of fault resistance in SLG faults and the effect of power swings.

3152.2 Relay Communications

Communication Requirements for Protection and Control in the 1990's, M.G. Adamiak and R.C. Patterson, Texas A&M Protective Relaying Conference, Apr. 15-17, 1991. This paper addresses the rapidly changing utility communication requirements which result from the implementation of digital technology in the areas of protection, control, and monitoring.

Design and Testing of a New Microprocessor Based Current Differential Relay for EHV Teed Feeders, R.H. Aggarwal, A. H. Husseini and M.A. Redfern, IEEE Trans. on Power Delivery, Vol. 6, No. 3, 1991, p 991-9. The paper describes the developments in the design and construction of the system, using fibre optical communications. The protection algorithm is based on deriving Differential and Bias signals based on Aerial mode components of currents (instead of phase currents) from the three line terminals.

The Use of Drop and Insert in Transmission Line Protective Relaying Communications, T.A. Phillippe, Texas A&M Protective Relaying Conference, Apr. 15-17, 1991. Newer technologies, such as digital communications and drop and insert can be applied to traditional relaying schemes, such as transfer trip and current differential schemes. This paper presents some of the applications and theories which accompany this topic.

3152.3 Relay Systems

Protection of Hydro Quebec's Series-Compensated Lines, J.P. Benoit and L. Champagne, Trans. CEA E&O Div., Vol. 30, 1991, Paper No. 91-SP-156. Hydro Quebec plans to install series compensation on 37 lines of its 735-kV transmission system from 1992 to 1995. The addition of series compensation, protected by ZnO varistors, and installed mostly at line ends, will require that the existing distance protection be replaced on a number of lines. A study conducted on IREQ's transient network analyzer (TNA) to determine which protective schemes should be used is described.

Protective Relaying Application for Geomagnetic Disturbances, B. Bozoki, CEA E&O Div., Vol. 30, 1991, Paper No. 91-SP-161. A severe geomagnetic disturbance could cause considerable damage to power equipment and may affect the stable operation of a transmission system. Mitigation of this potential problem would require expensive redesign of the power system. Beside the expense, the mitigation approach may have undesired side effects. The paper proposes a microprocessor based harmonic overcurrent

relay that responds to the geomagnetically induced currents in a desirable manner.

A Complex Protection Problem Solved, G.J. Breaux, Texas A&M Protective Relaying Conference, Apr. 15-17, 1991. This paper discusses one utility's experiences in relaying a loop transmission system serving industrial load. The system has three short lines that present unique relaying problems. The studies performed, problems found, and recommended actions are discussed.

A High-Speed Directional Comparison Protection for EHV Transmission Lines, A.T. Giuliante, J. Gosalia and G.K. Clough, 18th Annual Western Protective Relay Conference, Oct. 22-24, 1991. This paper describes a new directional comparison scheme which uses instantaneous changes in the line currents and voltages caused by a fault.

Digital Line Differential Protection Using Symmetrical Components, T. Lobos, Electric Power Systems Research, Vol. 22, 1991, p 85-89. A method for digital differential protection of lines is presented. The protection compares a time function and the symmetrical positive-sequence components at the two terminals of the line. A phase-independent operating time of less than half a period of the fundamental frequency can be achieved.

A Directional Comparison Protection for EHV Transmission Lines, S.J. Rose, A. Williams and S.F. Elson, Trans. CEA E&O Div., Vol. 30, 1991, Paper No. 91-SP-158. A directional comparison protection which, with the aid of a signalling channel, operates as a blocking or permissive over-reaching scheme is described. Details of the operating principle of the directional element, which uses superimposed signals to determine fault direction are provided. The technique provides high fault resistance coverage, and is insensitive to capacitor voltage transformer transients and heavy circuit loading.

Transmission Line Protection with Magneto-Optic Current Transducers and Microprocessor-Based Relays, E.A. Udren and T.W. Cease, 45th Annual Ga. Tech Protective Relaying Conference, May 1-3, 1991. This paper discusses one utility's data communication configuration and experience of an installation of three-phase magneto-optic current transformers and the associated relaying system that accepts these inputs.

3153 RELAY INPUT SOURCES

New Method for Monitoring and Protection of High Voltage Switchyards, D.W.E. Blatt, IEE Proceedings-C, Vol. 138, No. 3, 1991, p 228-32. The paper describes a remote magnetic field monitoring instrument transformer system which can monitor currents and detect in real-time system faults. The system can accomplish its functions by using remote magnetic field sensors and, is physically and electrically isolated from the network.

Co fused Current Transformers, G. Dalke, Texas A&M Protective Relaying Conference, Apr. 15-17, 1991. This paper is a tutorial on ct application and circuit design from a relay engineer's perspective. The intent is to provide enough information so that an engineer will be able to avoid misapplication of ct's.

Fiber Optics Improves Pilot-Wire Relaying and Communication Systems, D.A. Lukenbill, Transmission & Distribution, Vol. 43, No. 10, 1991, p 64-6. Fiber-optic cable is used to provide protective-relay pilot channels, voice communication, and data communications between two substations. An HCB-1 pilot-wire relay system is interfaced to the fiber-optic cable.

345 KV Substation Optical Current Measurement System for Revenue and Protective Relaying, T.D. Maffetone and T.M. McClelland, IEEE Trans. on Power Delivery, Vol. 6, No. 4, 1991, p 1430-7. The paper reports on the design, installation, and successful performance of a 345 kV substation optical current sensor. A pulse-width modulator interfaces the relay with a 5A output. Design decisions, test results, and future work are discussed.

DC Saturation of Differential Circuit CT's, R.H. Otto, 45th Annual Ga. Tech Protective Relaying Conference, May 1-3, 1991. This paper describes one utility's experience with ct saturation. It reinforces the need for the application of adequate current transformers during the design and engineering phase. The need for considering the X/R ratio is also discussed.

Transient Overvoltages in CT and VT Secondary Circuits in High-Voltage Substations, H. Remde and H. Schwarz, ABB Review, January 1991, p 29-34. This paper reports on the electromagnetic compatibility measures needed to reduce high stray overvoltages in the secondary circuits of cts and VTs in a 200-kV switch yard. These measures include shielding, earthing, segregation, filtering, special layouts, and use of two-wire systems.

3154 ROTATING MACHINERY PROTECTION

Design of a Combined Digital Global Differential and Volts/Hertz Relay for Step-Up Transformers, G. Benmouyal, IEEE Trans. on Power Delivery, Vol. 6, No. 3, 1991, p 1000-7. The paper presents specifications and design features of a new relay combining the functions of differential protection of a generator and its step-up transformer, volts/hertz overexcitation, and over-and under-frequency relays. The differential function uses 2nd and 5th harmonic restraint. Redundancy is obtained by implementing each function in two independent cases.

New England's 39 Years of Experience with Resonant Neutral Grounding of Unit-Connected Generators, E.M. Gulachenski and E.W. Courville, IEEE Trans. on Power Delivery, Vol. 6, No. 3, 1991, p 1016-24. The resonant grounding provides greater sensitivity for ground faults and lower fault current than resistor grounding. The advantages are illustrated by operating experiences and calculations for a typical generator.

Microcomputer Based Digital Differential Relaying for Generator Protection: Real Time Test Results, K. Soundararajan and H.K. Verma, Electric Power System Research, Vol. 20, 1991, p 237-243. The paper presents the development of a digital differential relaying scheme using a 16-bit microprocessor for generator winding protection. It uses a simple filter algorithm which is based on cross-correlation with a heptagonal wave for the extraction of fundamental frequency components of differential and sum currents.

Motor Bus Transfer Applications and Trends, K. Zimmerman and J.A. Burnworth, Texas A&M Protective Relaying

Conference, Apr. 15-17, 1991. This paper reviews the methods and application considerations of motor bus transfer. Some of the unique design considerations are included as well as operating experiences and problems of various users.

Motor Analysis for Protection Engineers, S.E. Zocholl, IEEE Computer Applications in Power, Vol. 4, No. 4, 1991, p 22-6. This paper describes MotorLab, a pc based motor analysis program, which provides graphical results of electrical, mechanical and thermal characteristics of motors and is useful for protection studies for high-inertia situations.

3155 OTHER PROTECTION

New Technologies: The Revolution in Substation Control and Protection, W. Litzenberger and J. Brunke, 18th Annual Western Protective Relay Conference, Oct 22-24, 1991. Radical changes are taking place in the procedures for designing substations. This paper discusses the upcoming revolution in the area of protection and control.

3155.1 Transformer and Reactor Protection

AI in Design: Searching for Differential Relay Protection, R.M. Hayes, IEEE Computer Applications in Power, Vol. 4, No. 3, 1991, p 21-6. This paper describes the "constraint-directed design" principle of Artificial Intelligence (AI) which has been applied to develop a differential relay setting program on a pc at the American Electric Power Service Corp. The "heart" of the principle is to navigate efficiently through the state space with the hope of discovering at least one member of the solution space.

A Stand-Alone Digital Protective Relay for Power Transformers, I. Hermanto, Y.V.V.S. Murty and M.A. Rahman, IEEE Trans. on Power Delivery, Vol. 6, No. 1, 1991, p 85-95. The relay includes 2nd harmonic restraint for inrush, 5th harmonic restraint for overexcitation, and a separate protection for high impedance ground faults with 2nd harmonic restraint to prevent tripping on inrush and ct saturation. Sample test cases of extensive real-time laboratory tests are reported.

Problems Protecting Phase - Shifting Transformers, P.E. Krausse and C.S. Miller, Transmission & Distribution, Vol. 43, No. 11, 1991, p 60-6. The authors analyze inrush currents and internal faults in phase-shifting transformers and describe a new relay protection scheme to achieve reliable operation and effective protection.

3155.2 Capacitor Bank and Static Var Protection

Guide for the Protection of Shunt Reactors (ANSI/IEEE C37.109), IEEE Power System Relaying Committee Report, IEEE Trans. on Power Delivery, Vol. 6, No. 1, 1991, p 116-8. This paper serves as an introduction to the new guide. It briefly describes the material in the guide and presents some examples. The protection of both dry type and oil-immersed reactors is covered.

230-KV Capacitor Bank Protection, P.W. Powell and J.F. Peggs, 45th Annual Ga. Tech Protective Relaying Conference, May 1-3, 1991. This paper describes the experience of a utility with neutral current unbalance protection for 230 kV grounded wye connected capacitor banks.

3155.3 Other Protection

Design of a Digital Multi-Curve Time-Overcurrent Relay, G. Benmouyal, IEEE Trans. on Power Delivery, Vol. 6, No. 2, 1991, p 656-65. The paper describes the design of a relay that can incorporate several relay functions with different time-current characteristics, each with independent settings and output. The relay uses a low-cost measuring circuit with response time of one half cycle and a broad dynamic range.

Expert System Applications to Protection, Substation Control and Related Monitoring Functions, M. Kezunovic, K. Watson and B. D. Russell, Electric Power Systems Research, Vol. 21, 1991, p 71-86. The paper surveys the present research efforts and future possibilities and trends in the applications of modern technologies in power system protection, substation operation, and monitoring.

Modern Approaches to Bus Protection And Breaker Failure Relaying, C.A. Kramer, 18th Annual Western Protective Relay Conference, Oct 22-24, 1991. This paper examines the basic concepts of protection of substation bus and breaker arrangements, and examines various protection schemes used for this application. Existing relay concepts are discussed and some modern approaches of providing the protection are introduced..

Interrupt-Driven Microprocessor-Based Overcurrent Relay, M.A. Manzoul, IEEE Trans. on Industrial Electronics, Vol. 38, No. 1, 1991, p 8-9. This paper describes an interrupt-driven overcurrent relay based on the INTEL 8085 microprocessor. The described relay requests processing time from the microprocessor only on the occurrence of a fault.

Relaying Process Modernized at Consumers Power Company, C.W. Rogers and J.A. Zipp, 45th Annual Ga. Tech Protective Relaying Conference, May 1-3, 1991. The purpose of this paper is to detail the evolution of the relaying process of the utility and describe where the 1990's will lead them.

A Microprocessor-Based System for Integrated Protection and Control, T.S. Sidhu, H.C. Wood and M.S. Sachdev, CEA E&O Div., Vol. 30, 1991, Paper No. 91-SP-162. Design and hardware aspects of a general-purpose microprocessor-based system for integrated protection and control is described. The system has been implemented at the University of Saskatchewan and has been used for protecting and monitoring power transformers. Expansion possibilities are discussed and the use of the system to protect and control a typical substation is illustrated.

Houston Lighting & Power's First Integrated Automated Substation, B.A. Vandiver III, R.W. Comfort, R.K. Tarver and A.L. Filla, Texas A&M Protective Relaying Conference, Apr. 15-17, 1991. Discussed is one utility's evaluation and decision process that allowed it to make the transition from electromechanical to microprocessor based integrated substation protection and control.

3156 FAULT AND SYSTEM CALCULATIONS

WESCARGO - A Systems Analysis Approach to Protective Device Coordination, J.J. Bonk, V.J. Kruse, P.R. Leblanc and G.L. Rankin, ABB Review, July 1991, p 15-20. WESCARGO is a software package that analyzes systematically system-wide coordination of protection systems. The main features

are fault study, protection system performance evaluation, automatic coordination and the system response map which identifies the critical coordination paths.

Computer Aided Coordination of Line Protection Schemes, IEEE Power System Relaying Committee Report, IEEE Trans. on Power Delivery, Vol. 6, No. 2, 1991, p 575-83. This report presents the functional requirements on the data base, software, and hardware required for this system, and the methods of presenting the output. The most important considerations in the design of the system are presented.

A Method of Analyzing Unsymmetrical Faults on Six- Phase Power Systems, E.H. Badway, M.K. El-Sherbiny, A.A. Ibrahim and M.S. Farghaly, IEEE Trans. on Power Delivery, Vol. 6, No. 3, 1991, p 1139-45. The unbalanced phasors of a six-phase system are split into two three-phase unbalanced systems. Each system is resolved using the conventional three-phase symmetrical components theory into three sets of balanced phasors.

Interactive Relay Controlled Power system Modelling, J.N. Peterson and R.W. Wall, IEEE Trans. on Power Delivery, Vol. 6, No. 1, 1991, p 96-102. A program has been developed with imbedded protective relay algorithms to permit relay controlled transient simulations. The fundamentals of each of the five building blocks are discussed. The designs can be efficiently analyzed by computer simulation before and after hardware development.

Coordination of Directional Relays without Generating all Circuits, V.C.Prasad, K.S.P. Rao and A.S. Rao, IEEE Trans. on Power Delivery, Vol. 6, No. 2, 1991, p 584-90. This paper shows that it is only necessary to identify a set of independent circuits for this purpose. There are only (e lines - v buses + 1) independent circuits on a set, which reduces the computational requirements. The method works for parallel lines and multi-terminal lines.

A Canonical Model for the Study of Faults in Power Systems, V.C. Strezoski and D.D. Bekut, IEEE Trans. on Power systems, Vol. 6, No. 4, 1991, p 1493-9. The paper derives a canonical model of a faulted power system for all types of faults. The procedure for solving the model as well as numerical examples are presented.

3157 TESTING AND ANALYSIS

Evolution and Application of Computerized Relay Testing, L.A. Barto and B.R. Raley, 45th Annual Ga. Tech Protective Relaying Conference, May 1-3, 1991. This paper outlines the development of a computerized relay testing program and provides insight into the benefits of such an approach.

Ways to Assure Improper Operation of Transformer Differential Relays, W.A. Elmore, Texas A&M Protective Relaying Conference, Apr. 15-17, 1991. There are many incorrect ways to connect current transformers. This paper is a tutorial which discusses many of these methods and provides an excellent basis of knowledge for the application engineer.

Relay Replacement and Upgrading Projects, C.F. Henville, Trans. CEA E&O Div., Vol. 30, 1991, Paper No. 91-SP-157. The experiences of BC Hydro in initiating relay replacement and upgrading projects are described. The description includes the procedure for establishing the scope, justifying the cost and experience with its implementation so far. The conclusion is that statistical information on system disturbances and financial benefits associated with protective relaying is very important in justifying the project.

Guide for Differential and Polarizing Relay Circuit Testing, IEEE Power System Relaying Committee Report, IEEE Trans. on Power Delivery, Vol. 6, No. 3, 1991, p 986-90. The paper calls attention to and summarizes the new guide, C37.103. Tests are described to verify that all current and voltage circuits are properly connected to the relays after initial installation and after any circuit changes. Then, in-service load tests which should be conducted when the facilities are first energized are described.

Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers, IEEE Power System Relaying Committee Report, IEEE Trans. on Power Delivery, Vol. 6, No. 1, 1991, p 103-8. This paper discusses the Trial Use Standard C37.90.2 for a design test to verify correct operation of static relays when subjected to RF transmission such as from walkie-talkies. The test covers the frequency range from 25 to 1000 MHz.

Realistic Relay Tests Need Fault Reconstruction, J. Reason, Electrical World, Vol. 205, No. 5, 1991, p 41-2. This article discusses the next generation of relay testers that apply an actual fault waveform to the relay under test. Three fault simulators and their overall capabilities are briefly described.

A Personal Computer Based System for the Laboratory Evaluation of High Performance Power System Protection Relays, M.A. Redfern, R.K. Aggarwal and A.H. Husseini, IEEE Trans. on Power Delivery, Vol. 6, No. 4, 1991, p 1402-8. The paper describes a system using digital transient simulation programs to model the power system's conditions and high fidelity current and voltage amplifiers to feed the relay under test. The application of the system is illustrated by evaluating a new EHV Teed feeder relay.

PC Based Analysis of Impedance Relay Applications, A.G. Bosgoed, 18th Annual Western Protective Relay Conference, Oct 22-24, 1991. An impedance relay modelling program utilizing personal computer based graphical analysis methods is described. Its benefits and operating principles, and experience with its use are outlined.

DYNA-TEST Simulator for Relay Testing Part 1: Design Characteristics, M. Kezunovic, A. Abur, L. Kojovic, V. Skendzic, H. Singh, C.W. Fromen and D.R. Sevcik, IEEE Trans. on Power Delivery, Vol. 6, No. 4, 1991, p 1418-29. The DYNA-TEST Simulator, described in the paper, is intended for transient testing of protective relays. It models the power system for simulating faults. The transient behaviour of cts and CVTs are included. System data recorded by a digital fault recorder can also be used to investigate relay performance for actual fault conditions.

Discover Relay Design and Application Problems Using Pseudo-Transient Tests, C.F. Henville and J.A. Jodice, IEEE Trans. on Power Delivery, Vol. 6, No. 4, 1991, p 1444-52. Pseudo-transient simulation tests help discover limitations of relay applications and explain unexpected operations. The test method, using commercially available test equipment, is briefly described. Test results and limitations of the method

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A Real Time Digital TNA for Relay Testing, P.G. McLaren, R. Kuffel, R. Wierckx, J. Giesbrecht and L. Arendt, 18th Annual Western Protective Relay Conference, Oct 22-24, 1991. This paper describes the design and performance of a real time digital transient network analyzer for testing relays. Examples of tests on a commercial distance relay are presented.

Closed Loop Relay Testing with Real Time Electromagnetic Transients Simulation, P.G. McLaren, R. Wierckx, R. Kuffel, L. Arendt, J. Giesbrecht and J.R. Lucas, Trans. CEA E&O Div., Vol. 30, 1991, Paper No. 91-SP-154. This paper outlines the design and performance of a real time digital simulator (RTDS) for testing relays in interactive mode. The RTDS uses parallel processing architecture to run electromagnetic transient simulations in real time with a time step of the order of 100μs. The program runs until stopped from the input keyboard. The output can be used to test primary protection, back-up protection and power swing blocking.

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Dynamic Oscillations Predicted by Computer Studies, M.M. Butts and H.S. Smith, IEEE Computer Applications in Power, Vol. 4, No. 1, 1991, p 47-51. This paper highlights results from the 1988-89 dynamic stability performance studies of the Georgia Power Company's Plant Scherer. The time-domain study concluded that a unit be tripped for the loss of a 500-kV line. The frequency-domain study verified the results of the time-domain study.

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Automatic Synchronizing for Generation and Tie Lines, W.G. Hartmann, 45th Annual Ga. Tech Protective Relaying Conference, May 1-3, 1991. This paper addresses the concerns associated with synchronous and asynchronous system conditions as they relate to the application of relaying systems involving sync check and automatic synchronizing relays.

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