BIBLIOGRAPHY OF RELAY LITERATURE, 1992
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, 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	Particulars of the Transaction 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 - Paper # 92 SM 385-5 to be published in PWRD-8.

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:

93 SM 379-8 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 1993 Summer Meeting, Vancouver, B.C., Canada, July 18-22, 1993. Manuscript submitted Mar. 17, 1993; made available for printing Apr. 5, 1993.

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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 several countries are covered.

In addition to the papers published in Journals and Conference Proceedings, two books on the subject of power system relaying have come to the attention of the Working Group. A brief description of their contents is included here.

Protective Relaying for Power Systems II, Editor - S.H. Horowitz, IEEE, 560 pp. This book is in continuation to Volume I published in 1980. It is a collection of selected papers prepared by IEEE Committees and individuals which have been published in the IEEE Transactions during the last fifteen years. The subjects covered include fundamental considerations, input sources, digital relays, monitoring and, protection of transmission lines, substation equipment and rotating machines.

Power System Relaying, S.H. Horowitz and A.G. Phadke, John Wiley and Sons Inc., New York, 284 pp. The subjects covered include operating principles of relays, current and voltage

transformers, protection of transmission lines, transformers, reactors, capacitors, station bus and rotating machinery. Philosophy underlying the selection of relaying systems is presented and relaying practices in U.S.A., Europe and Asia are compared.

3150 RELAYING ALGORITHMS

The Technique of Finite-Impulse-Response Filtering Applied to Digital Protection and Control of Medium Voltage Power System, P. Bastard, P. Bertrand, T. Emura and M. Meunier, IEEE Trans. on Power Delivery, Vol. 7, No. 2, 1992, p 620-6. For digital protection systems, the definition of fault criteria is established from digitized signals. This paper deals with the magnitude and phase shift of the fundamental. A general method for designing a Finite-Impulse-Response filter is given, and then how to lead a performance evaluation of a digital relaying algorithm based on F.I.R. filtering.

Frequency-Domain Characterization of Kalman Filters as Applied to Power System Protection, G. Benmouyal, IEEE Trans. on Power Delivery, Vol. 7, No. 3, 1992, p 1129-38. This paper shows that conventional tools such as frequency response and time response to a unit sine wave step function can be successfully applied for performance analysis. The influence of noise is considered.

Microprocessor-Based UHS Distance Relaying Using Advanced Generation Signal Processing, P.K. Dutta and P.B. Duttagupta, IEEE Trans. on Power Delivery, Vol. 7, No. 3, 1992, p 1121-8. Three distinct types of travelling wave distance relaying algorithms are developed and their performances are evaluated with varying system configurations, fault resistance, and fault distances.

Envelope Compensation for High Speed Digital Protection, B.S.A. Kumar, K. Ganesan and E.F. Rivera, IEEE Trans. on Power Delivery, Vol. 7, No. 3, 1992, p 1139-47. Filters are used in high speed relaying techniques to reduce the effects of harmonics and dc components, but add time delay. This paper outlines a reliable method of delay compensation. The new convergence function does not cause increased overreaching, oscillations, or erratic estimations.

A Novel Algorithm for Digital Protection of Power Transformers, H. Lihua, Y. Yilin, M.A. Rahman, D.T.W. Chan and P.K.S. Ong, Trans. CEA E&O Div., Vol. 31, 1992, Paper No. 92-SP-165. The paper proposes an algorithm for digital protection of a power transformer. The proposed algorithm has high frequency optimality index and small computational burden. Simulation results illustrating the performance of the algorithm are also included.

Fast Estimation of Symmetrical Components in Real Time, T. Lobos, IEE Proceedings-C, Vol. 139, No. 1, 1992, p 27-30. Methods for on-line calculation of the phasors of symmetrical components are presented. The methods combine the suppression of higher frequencies and the separation of symmetrical components. The proposed approach uses a variable sampling window to enable a faster estimation.

A New Kalman Filter Approach to Digital Relaying, J.L. Pinto de Sa, IEEE Trans. on Power Delivery, Vol. 7, No. 3, 1992, p 1652-60. This paper shows how to include the analog pre-filters' transients in the Kalman Filter state space. The coloring effect that the pre-filters and the network itself have upon the noise can also be handled by slightly augmenting the Kalman Filter system model.

The Stochastic Modeling of Fault-induced Transients, J.L. Pinto de Sa, IEEE Trans. on Power Delivery, Vol. 7, No. 3, 1992, p 1156-66. A study on the stochastic characterization of fault induced transients is performed, considering time-dependence for both variance and autocorrelation. The aim is to define noise models for the design and evaluation of digital relaying algorithms.

Detection of High Impedance Arching Faults Using an Artificial Neural Network, G.W. Swift, A.F. Sultan and D.J. Fedirchuk, 19th Annual Western Protective Relay Conference, Oct 20-22, 1992. This paper discusses the development of an algorithm which identifies high impedance faults. Results of various tests are also presented.

Primary Protective Relays with Elements of Expert Systems, A. Wiszniewski and B. Kasztenny, CIGRE, Paris, Aug 30-Sep 5, 1992, Paper No. 34-202. The paper discusses the use of artificial intelligence in the decision-making module of protective relays. The concept of fuzzy settings and the use of fuzzy logic for decision making within relays are presented.

3151 DISTRIBUTION AND NETWORK PROTECTION

A Digital Multifunction Protective Relay, M.V.V.S. Yalla, IEEE Trans. on Power Delivery, Vol. 7, No. 1, 1992, p 193-201. The paper describes the development of a relay for the protection of the intertie between a customer owned generator and a utility system. A dual microprocessor architecture achieves flexibility and high speed. The signal processing algorithms, and relay software and hardware are described.

3151.1 Industrial and Power Station Auxiliaries

Polyethylene Current Limiters for Short-Circuit Protection, T. Hansson, ABB Review, 1992, pp. 35-8. This paper describes a new current limiter developed using doped polymers which when connected in series with a circuit breaker offers cost-effective short-circuit protection in industrial applications. Current limiters employing this technology respond to fault currents in 0.1 to 1.0 ms.

3151.2 Primary Distribution Systems

Integration of Digital Protection, Control and Monitoring in Distribution Substations, J.B. Bunch, D.P. Das, S.C. Patel and G.W. Cunningham, 45th Annual Texas A&M Protective Relay Conference, Apr 13-15, 1992. The inclusion of protection, control and monitoring functions into an integrated system approach can provide significant economic and operational benefits. This paper discusses some of these issues as they relate to the future utility direction.

Serving Non-Typical Distribution Loads at Nashville Electric Service, R.M. Hale and L.E. Leech, 46th Annual Georgia Tech Protective Relaying Conference, Apr 29-May 1, 1992. A small number of customers, because of the size of their load, or more often because of other characteristics of the load, require closer attention and special arrangements for service. This paper discusses how one utility has dealt with this situation.

Automatic & Remote Transfer Switches Increase Distribution System Dependabillity, S. Howard and J. Sharp, Transmission and Distribution, Vol. 44, No. 4, 1992, p 40-6. In-house designed auto-transfer scheme helps to reduce outage time in remote feeder areas.

Application of New Microprocessor Distribution Protection and Monitoring Devices, B.W. Jackson, 46th Annual Georgia Tech Protective Relaying Conference, Apr 29-May 1, 1992. This paper

reviews the improvements in protection that a utility has implemented and describes the functions that are available on the new microprocessor equipment.

Overcurrent Relay Coordination Margins, J.J. Kilic, S.E. Hicks and R.T. Casey, 46th Annual Georgia Tech Protective Relaying Conference, Apr 29-May 1, 1992. This paper is an investigation into the question, "How much coordination margin is necessary between a bus tie relay and a feeder relay in a distribution substation?"

Electronic Relays Help at Distribution Level, G. Paula, Electrical World, Vol. 206, No. 10, 1992, p 66-7. Burlington (VT) Electric Department has started to use microprocessor-based relays on their distribution circuits. Functions utilized are overcurrent protection for three zones, reclosing, fault location, data collection and communication.

An Adaptive Relaying Approach to Distribution System Protection, M.S. Sachdev, B. Chattopadhyay and T.S. Sidhu, 19th Annual Western Protective Relay Conference, Oct 20-22, 1992. This paper outlines the design features of an adaptive relaying system for a distribution network, including a description of the software and hardware. The implemented scheme is briefly outlined. The paper examines the consequences of communication failure between the relays and the station computers.

Microcomputer Based Adaptive Relaying for a Distribution System - A Case Study, M.S. Sachdev, B. Chattopadhyay and T.S. Sidhu, Trans. CEA E&O Div., Vol. 31, 1992, Paper No. 92-SP-176. The paper presents the design of an adaptive relaying scheme for the "City of Saskatoon" distribution system. The software developed for the application is described. The implementation of the scheme and some system studies are presented.

Advanced Fault Circuit Indicators are Evaluated, J.N. Stock and W.R. Schmus, Transmission and Distribution, Vol. 44, No. 1, 1992, p 72-6. New technology allows logic using pulse current, absence of current and load current to create reliable fault indication.

Detection of High Impedance Arcing Faults Using Multi-Layer Perceptron, A.F. Sultan, G.S. Swift and D.J. Fedirchuk, IEEE Trans. on Power Delivery, Vol. 7, No. 4, 1992, p 1871-7. An artificial neural network was trained by high impedance fault, fault-like load, and normal load patterns. Neural network parameters were embodied in a high impedance arcing fault detection algorithm. The algorithm was tested by normal load currents disturbed by currents of faults on dry and wet soil, an arc welder, computers, and fluorescent lights.

Improvements in Distribution Feeder Protective Relaying, R.P. Taylor, A.T. Giuliante and J. Gosalia, 19th Annual Western Protective Relay Conference, Oct 20-22, 1992. This paper describes some features of a new line of microprocessor-based overcurrent relays which have built-in communication ports to allow remote access. Also discussed are some of the barriers that must be overcome to take full advantage of this technology and use it effectively.

Computer-Aided Recloser Applications for Distribution Systems, J.F. Witte, S.R. Mendis, M.T. Bishop and J.A. Kischefsky, IEEE Computer Applications in Power, Vol. 5, No. 3, 1992, p 27-32. The paper focuses on the computer-aided application of reclosers in distribution systems. An expert system is outlined which is built into a coordination program for establishing a functional protection system. An example illustrates the use of the expert system module in the coordination of multiple overcurrent devices.

3152 TRANSMISSION LINE PROTECTION

Theoretical Concept and Digital Simulation of the Pramod Scheme for UHS Protection of EHV Transmission Lines, P. Agrawal, IEEE Trans. on Power Delivery, Vol. 7, No. 3, 1992, p 1104-11. This paper describes the theoretical concept of the Pramod scheme. The principle is based on detection of the fault induced high frequency signals in the kilo Hertz range. A technique for digital simulation of the transmission line and detecting circuit is explained.

A Digital Protection Technique for Parallel Transmission Lines Using a Single Relay at Each End, M.I. Gilany, O.P. Malik and G.S. Hope, IEEE Trans. on Power Delivery, Vol. 7, No. 1, 1992, p 118-25. The described scheme uses the average current of corresponding phases in a single relay at each end of the two lines. Operating time is about 5 ms. The stability of the relay under different operating conditions is also examined.

Microprocessor Based Three Step Quadrilateral Distance Relay for the Protection of EHV/UHV Transmission Lines, G. Gongadharan and P. Anbalagan, IEEE Trans. on Power Delivery, Vol. 7, No. 1, 1992, p 91-7. The described relay uses the Fourier transform method to extract fundamental components of current and voltage. Any quadrilateral characteristic may be obtained. A maximum operating time of 15 ms is exhibited for zone 1 operation.

Ultra-High Speed Protection of Series Compensated Lines, D.W.P. Thomas and C. Christopoulos, IEEE Trans. on Power Delivery, Vol. 7, No. 1, 1992, p 139-45. An ultra-high speed protective algorithm based on travelling waves is developed and applied to series compensated lines. The basic principles of the algorithm are described and its response to protective gap flashover is studied for a range of fault conditions.

3152.1 Distance and Ground Relaying

Ground Distance Relaying: Problems and Principles, G.E. Alexander and J.G. Andrichak, 19th Annual Western Protective Relay Conference, Oct 20-22, 1992. Discussed in this paper are the operating principles of ground distance functions and some of the limitations or problems that can be encountered in their application. This paper discusses distance functions of the "phase angle comparator" design.

Evaluating and Replacing Back-up Line Distance Relays, J.M. Carrasco, Transmission and Distribution, Vol. 44, No. 2, 1992, p 26-33. This paper describes the evaluation that the City of Riverside Public Utilities Department underwent to replace outdated electro-magnetic distance relays with new microprocessor based relays.

Auto-Loop Management System Allows Certain Functions to be Remotely Controlled, L. Criso, Transmission and Distribution, Vol. 44, No. 12, 1992, p 38-44. Relays and controls provide automatic sectionalizing of distribution circuits to promote improved service reliability.

Applying Pattern Recognition in Distance Relaying Part 1: Concepts, S.K. Chakravarthy, C.V. Nayar and N.R. Achuthan, IEE Proceedings-C, Vol. 139, No. 4, 1992, p 301-5. Limitations of the existing operating characteristic of distance relays are discussed. The paper then introduces the concept of obtaining the operating

characteristics of distance relays by applying the method of pattern recognition.

Applying Pattern Recognition in Distance Relaying Part 2: Feasibility, S.K. Chakravarthy, C.V. Nayar and N.R. Achuthan, IEE Proceedings-C, Vol. 139, No. 4, 1992, p 306-14. This part of the paper reports results of testing the concept of applying pattern recognition to distance relays. The performance of the discriminant function in selecting an operating characteristic for a distance relay is evaluated for zone-1 operation. Generation of learning sets to establish the operating characteristic of distance relays is also discussed.

Zero Sequence Mutual Effects on Ground Distance Relays and Fault Locators, W.A. Elmore, 45th Annual Texas A&M Protective Relay Conference, Apr 13-15, 1992. Zero sequence mutual effects have been a source of concern for many years and extensive studies have been conducted. This paper describes the phenomenon in basic terms and provides some assistance in evaluating the severity of its influence.

Transmission Line Zero Voltage Fault Protection, B.A. Matta and J.K. Curtis, 46th Annual Georgia Tech Protective Relaying Conference, Apr 29-May 1, 1992. Three different methods of providing zero voltage fault protection are presented. A comparison of the schemes and a utility's experience with them are presented.

Performance of Adaptive Distance Protection Under High Resistance Earth Faults, P.J. Moore and A.T. Johns, CIGRE, Paris, Aug 30-Sep 5, 1992, Paper No. 34-203. The paper reviews the problem of incorrect distance relay operation during high resistance earth faults. Three methods of adapting digital distance relays to achieve better performance during high resistance earth faults are examined. One of the methods is shown to provide a significant improvement.

Reliable Directional Relay Based on Compensated Voltage Comparison for EHV Transmission Lines, Y.Q. Xia, J.L. He and K.K. Li, IEEE Trans. on Power Delivery, Vol. 7, No. 4, 1992, p 1955-62. The emphasis of this paper is on the description of the relaying algorithm, hardware and software design, and the testing result on a dynamic power system model. The relay is suitable for directional comparison blocking relaying schemes.

Fundamental Approach to Impedance Relaying, O.A.S. Youssef, IEEE Trans. on Power Delivery, Vol. 7, No. 4, 1992, p 1861-70. The paper presents a technique for computing transmission line impedance. The features of the approach are eliminating the transient components in the relaying signals, removing the dc offset component and accounting for the decay rate. The data window is one cyle plus one sample and the frequency response of the technique is highly selective.

3152.2 Relay Communications

Substation Communication: Drivers, Direction, and Road Blocks, M.G. Adamiak, 45th Annual Texas A&M Protective Relay Conference, Apr 13-15, 1992. This paper discusses some of the opportunities that utilities face as the availability of data on the system has outpaced the ability to communicate with the data collection devices in an efficient manner.

Charge Comparison Protection of Transmission Lines: Communication Concepts, N.P. Albrecht, W.C. Fleck, K.J. Fodero and R.J. Ince, IEEE Trans. on Power Delivery, Vol. 7, No. 4, 1992, p 1853-60. Charge Comparison is a completely digital relaying/communications system, suitable for analog voice band channels as well as wide-band digital or fiber-optics. In addition to charge comparison data, numerous auxiliary messages are sent. To accommodate all this information in a 7200 bps bit-stream, a unique message structure was devised.

NSD70 - A New Family of Programmable, Digital Protection Signalling Equipment, H. Spiess, ABB Review, 1992, p 3-10. This paper presents a new family of digital teleprotection equipment named NSD 750. It is programmable and has the versatilty needed for transmiting protection signal over digital as well as analog channels.

New Relay Salvages Communication System, T.E. Wiedman, F.J. Gerleve, M.S. Simon and R.C. Patterson, Electric Light and Power, Vol. 70, No.12, 1992, p 24-9. Useful life of an analog microwave communications system and associated relay schemes is extended through a new carrier relay developed jointly by a utility and a vendor.

New Travelling-Wave Based Scheme for Fault Detection on Overhead Power Distribution Feeders, M. El-hami, L.L. Lai, D.J. Daruvala and A.T. Johns, IEEE Trans. on Power Delivery, Vol. 7, No. 4, 1992, p 1825-33. This paper describes the operating principle of a new fault locator, with a new scheme for fault localisation. The fault locators, consisting of a wave trap and stack tuners, are placed at strategic points and at convenient intervals along an overhead feeder.

Design of a Dependable Microprocessor-Based Relay for Transmission Line Protection, M.S. Sachdev and T. Adu, Trans. CEA E&O Div., Vol. 31, 1992, Paper No. 92-SP-159. The paper describes the design of a dependable microprocessor-based transmission line relay which incorporates three digital algorithms operating in parallel. The results presented in the paper show the suitability of the proposed relay design.

3152.3 Relay Systems

Protection Requirements for Flexible AC Transmission Systems, M. Adamiak and R. Patterson, CIGRE, Paris, Aug 30-Sep 5, 1992, Paper No. 34-206. The paper presents the protection requirements and proposed protection approaches for a power system where Flexible AC Transmission Systems (FACTS) are implemented. The adaptive techniques, response times and control interfaces of a typical FACTS protection system are discussed. Testing and evaluation of the FACTS protection systems is reviewed.

Power System Protection in HVDC Environments, F. Andersson and L. Juhlin, ABB Review, 1992, p 27-32. This paper explores the problems that may arise in ac line protection when large HVDC systems are connected to relatively weaker ac systems and provides some solutions to these problems.

Protecting NYSEG's Six-Phase Transmission Line, A. Apostolov and W. George, IEEE Computer Applications in Power, Vol. 5, No. 4, 1992, p 33-6. The paper discusses the protection requirements of the NYSEG's six-phase transmission line. The protection system chosen includes current differential, directional comparison and distance protection. Test setup to determine the suitability of the chosen protection system is described in the paper.

Current Differential and Phase Comparison Relaying Schemes, J.F. Calero and W.A. Elmore, 46th Annual Georgia Tech Protective Relaying Conference, Apr 29-May 1, 1992. This paper clarifies the

difference between current differential and phase comparison relaying schemes, and points out advantages and disadvantages of these schemes as contrasted with distance schemes. Also discussed are the significant influences that power system parameters have upon their satisfactory operation.

A New Digital Transmission Line Current Differential Relay System - Concepts and Test Results, L.J. Ernst, W.C. Fleck and W.L. Hinman, 45th Annual Texas A&M Protective Relay Conference, Apr 13-15, 1992. An alternate form of current differential relaying called "charge comparison" is presented. It overcomes some of the communication problems associated with traditional current differential relaying, making this form of protection more attractive.

Charge Comparison Protection of Transmission Lines: Relaying Concepts, L.E. Ernst, W.L. Hinman, D.H. Quam and J.S. Thorp, IEEE Trans. on Power Delivery, Vol. 7, No. 4, 1992, p 1834-52. This is a form of current differential relaying which resolves three critical problems of current differential relaying: 1. Protection is lost if channel fails, 2. High capacity channel required, 3. Precise channel delay compensation required. The scheme is suitable for 3 terminal lines.

Relaying at the Speed of Light: Pilot Relaying on Optical Channels, J.D. Huddleston III, 46th Annual Georgia Tech Protective Relaying Conference, Apr 29-May 1, 1992. This paper relates one utility's experience with various pilot relaying systems that use fiber optic channels.

Protection Considerations for Bull Sluice 500 KV Substation, J.W. Miller, 46th Annual Georgia Tech Protective Relaying Conference, Apr 29-May 1, 1992. Technical advancements in switchgear and relaying have increased opportunities for new protective relay applications. This paper describes how one utility took advantage of these advancements while designing the relaying for a new 500/230-KV GIS substation.

Selection and Application of Relay Protection for Six Phase Demonstration Project, R.V. Rebbapragada, H. Panke, H.J. Pierce, J.R. Stewart and L.J. Oppel, IEEE Trans. on Power Delivery, Vol. 7, No. 4, 1992, p 1900-11. Conversion of a double circuit 115 kv line to a 93 kv 6 phase line is planned. Criteria for selection and application of protection systems is developed. Commercially available digital 3 phase current differential and phase comparison systems are planned. Recommendations for implementing supplementary relay logic to achieve single phase trip capability are given.

Thailand's First two 500-kv Substations Successfully Commissioned, W. Rochanapithyakorn, B. Frentzen and H. Kaiser, ABB Review, 1992, p 3-10. This paper describes the switchgear and protection equipment designed and commissioned at the first two 500 kV substations in Thailand. Redundant pilot schemes, one employing microwaves and the other with fiber are described.

Distance Relay Element Design, E.O. Schweitzer III and J. Roberts, 19th Annual Western Protective Relay Conference, Oct 20-22, 1992. This paper presents the design of a basic distance and directional element. Emphasis is placed on relating the new digital and numerical methods to the established electromechanical and static-analog methods of designing relay elements.

A Digital Multifunction Relay for Intertie and Generator Protection, M.V.V.S. Yalla and D.L. Hornak, Trans. CEA E&O Div., Vol. 31, 1992, Paper No. 92-SP-157. A multifunction relay for the protection of generators and the intertie between non-utility generation and the utility system is described in the paper. The relay provides fourteen protection functions, serial communications, and fault recording facilities.

3153 RELAY INPUT SOURCES

Relay Potential Grounding Problems on Texas Utilities Electric System, D.F. Faulk, 45th Annual Texas A&M Protective Relay Conference, Apr 13-15, 1992. This paper discusses two separate cases that occurred when two or more grounds existed on a PT or CCVT secondary circuit for relaying. The improper operations resulting from this arrangement are also discussed.

Review of Harmonic Standards - IEEE 519, W.M. Grady, 45th Annual Texas A&M Protective Relay Conference, Apr 13-15, 1992. The "IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems" was recently approved by the IEEE Standards Board. This paper serves as a tutorial on the subject of harmonics and gives a chapter-by-chapter review of the document.

Digital Models of Coupling Capacitor Voltage Transformers for Transient Protective Relaying Studies, M. Kezunovic, L. Kojovic, V. Skendzic, C.W. Fromen, D.R. Sevcik and S.L. Nilsson, IEEE Trans. on Power Delivery, Vol. 7, No. 4, 1992, p 1927-35. Experimental techniques for laboratory measurements of CCVT parameters are outlined. A sensitivity study identified the influence of various CCVT parameters on the transient behavior. Digital models of three CCVTs are given and their transient behavior compared to that of the actual transformers.

Development and Field Test Evaluation of Optical Current and Voltage Transformers for Gas Insulated Switchgear, S. Kobayashi, A. Horide, I. Takagi, M. Higaki, G. Takahashi, E. Mori and T. Yamagiwa, IEEE Trans. on Power Delivery, Vol. 7, No. 2, 1992, p 815-21. The GIS design avoids voltage stress of optical fibers in SF_6 gas insulation space. Long term field test results are given.

Improved Simulation Models for Current and Voltage Transformers in Relay Studies, J.R. Lucas, P.G. McLaren, W.W.L. Keerthipala and R.P. Jayasinghe, IEEE Trans. on Power Delivery, Vol. 7, No. 1, 1992, p 152-9. The improved models use a magnetizing characteristic based on the non-linear power curve formulation of Lucas. The flux-current loops of the core are self generated. The results show that the models behave as expected and agree with field investigations.

Development of a Fiber Optic Current Sensor for Power Systems, T. W. MacDougall, D. R. Lutz and R.A. Wandmacher, IEEE Trans. on Power Delivery, Vol. 7, No. 2, 1992, p 848-52. This paper discusses the design requirements of new, all optic fiber current sensors. The measurement uses the Faraday magneto-optic effect which causes rotation of the plane of polarization of light in the fiber.

Calculation of the Transient Performance of Protective Current Transformers Including Core Hysteresis, D. O'Kelly, IEE Proceedings-C, Vol. 139, No. 5, 1992, p 455-60. A digital simulation technique, which represents both hysteresis and eddy current action in the core steel, is used to compute current wave shapes and flux excursions for a wide range of fault current parameters. The paper also examines the production of residual core flux and its effect on secondary-current output.

Improper Grounding Effects on Cross-Polarized and Self-Polarized Relays, M.B. Saacks, 45th Annual Texas A&M Protective Relay Conference, Apr 13-15, 1992. This paper discusses the impact that grounding practices have on the ability of a relay to properly determine the fault location. Several examples are presented for phase to ground faults on cross-polarized and self-polarized relays.

Filtering for Protective Relays, E.O. Schweitzer III and D. Hou, 19th Annual Western Protective Relay Conference, Oct 20-22, 1992. This paper identifies filtering requirements or criteria for different relays. Discussion is limited to the applications requiring precise measurements of system-frequency component of the signal, such as distance relays.

Phase Angle Measurement Applications- A New Transducer That Measures State Variables in Real Time, C. Slivinsky, S. Stanton, J. Esztergalyos, J. Nordstrom, K. Martin, P.S. Sterlina, P.K. Lemme and V.A. Centeno, 19th Annual Western Protective Relay Conference, Oct 20-22, 1992. A new transducer has been developed that measures voltage and current with high accuracy at 2.88 kHz. This transducer is a Phasor Measurement Unit that can greatly improve the protection and control of the power system.

Current Transformer Concepts, S.E. Zocholl, 46th Annual Georgia Tech Protective Relaying Conference, Apr 29-May 1, 1992. This paper reviews the accuracy ratings of C and K bushing type cts and their implications in relay application. A computer simulation is also introduced and used to analyze specific ct applications in transformer and generator differential relays.

3154 ROTATING MACHINERY PROTECTION

Field Experience with Digital Relay for Synchronous Generators, G. Benmouyal, S. Barceloux and R. Pelletier, IEEE Trans. on Power Delivery, Vol. 7, No. 4, 1992, p 1984-92. The paper describes tests of the prototype digital generator relay developed by Hydro-Quebec. The relay provides protection functions for stator current differential, loss-of-excitation, current balance, motoring, overvoltage, overcurrent with voltage restraint, and 100% stator ground fault. The relay was placed in service on a generator and binary outputs permitted an SER to monitor the relay operation.

Focus on Motor Controllers, B. Brickhouse and W. Hoffman, Electric Light and Power, Vol. 70, No. 2, 1992, p 23-5. Microprocessor based relays provide standard motor protection with the added advantage of fine-tuning for each particular motor or application.

3155 OTHER PROTECTION

Considerations for Specifying 69 kv Shunt Capacitor Banks, G.e. Fenner, Transmission and Distribution, Vol. 44, No. 9, 1992, p 39-44. Fuses, overcurrent, over- and under-voltage, and neutral voltage unbalance are methods for protecting 69 kv ungrounded capacitor banks at minimum cost.

3155.1 Transformer and Reactor Protection

Advances in the Design of Differential Protection for Power Transformers, A.T. Giuliante and G.K. Clough, 45th Annual Texas A&M Protective Relay Conference, Apr 13-15, 1992. Discussed in this paper are the basic concepts of transformer differential protection including some of the potential drawbacks of using harmonic restraint. Modern electronics allows techniques to be used to overcome some of these problems and a relay designed with this in mind is presented.

Protection of the East Garden City 345KV Phase Angle Regulating Transformers, M.A. Ibrahim and F. Stacom, 46th Annual Georgia Tech Protective Relaying Conference, Apr 29-May 1, 1992. This paper discusses the various aspects of protection and control of a 345KV phase angle regulating transformer.

Improved Operation of Differential Protection of Power Transformers for Internal Faults, P. Liu, D. Chen, Y. Guo, O.P. Malik and G.S. Hope, IEEE Trans. on Power Delivery, Vol. 7, No. 4, 1992, p 1912-9. This paper studies the possibility of the 2nd harmonic restraint relays not operating for faults in transformers. The operation of three algorithms are analyzed for a large number of faults and magnetizing inrush. Modified schemes to improve operation are presented.

An Adaptive Transformer Overload Relay, T.S. Molinski, G.T. Wong, Z. Zhang, G. Swift, P. McLaren and E. Dirks, 19th Annual Western Protective Relay Conference, Oct 20-22, 1992. A transformer overload relay that adjusts its pick-up setting in response to several input variables is described. A relay adjusts its settings based on rate of loss of life and cold load pickup for permitting "maximum" use of the transformer overload capability.

Nelway Substation Phase Shifting Transformer Protection, F.P. Plumptre, Trans. CEA E&O Div., Vol. 31, 1992, Paper No. 92-SP-174. The paper describes the application of off-the-shelf protection devices to protect the Nelway substation phase shifting transformer.

Design, Implementation, and Testing of a Microprocessor-Based High Speed Relay for Detecting Transformer Winding Faults, T.S. Sidhu, M.S. Sachdev, H.C. Wood and M. Nagpal, IEEE Trans. on Power Delivery, Vol. 7, No.1, 1992, p 108-17. Instead of relying on the presence of harmonics to identify magnetizing inrush, the described relay uses a non-linear model of the transformer to determine the state of its health. The winding resistance and reactance plus turns ratio are required input data.

On-line Identification of Magnetizing Inrush and Internal Faults in Three Phase Transformers, T.S. Sidhu and M.S. Sachdev, IEEE Trans. on Power Delivery, Vol. 7, No. 4, 1992, p 1885-91. The system described in this paper uses a digital algorithm that does not rely on the presence of harmonic components in the difference current to identify magnetizing inrush. It uses a transformer model whose outputs are identical to the transformer during normal operation and magnetizing inrush but not during a fault.

3155.2 Capacitor Bank and Static Var Protection

Effect of Geomagnetically-Induced Currents on Static Var Compensator Protection Systems, H. Bilodeau, S.R. Chano and J.P. Chayer, Trans. CEA E&O Div., Vol. 31, 1992, Paper No. 92-SP-178. The paper describes the effect of harmonically distorted waveforms on static var compensator (SVC) protective relays. Test results obtained from a simulator study and showing the behaviour of protective relays are given. Potential protection problems due to geomagnetically induced currents are identified.

Capacitor Control Using a Programmable Controller, G.D. Broyhill, Jr., 46th Annual Georgia Tech Protective Relaying Conference, Apr 29-May 1, 1992. This paper presents one utility's experience with using programmable controllers to provide the control function

for transmission capacitor banks.

Protection and Control of MOV Protected Series Capacitor Banks, F.P. Plumptre, Trans. CEA E&O Div., Vol. 31, 1992, Paper No. 92-SP-146. The application of protection and control equipment to MOV protected capacitor banks is discussed. A brief review of the B.C. Hydro's experience in planning and operating nine series capacitor banks on their system is also included in the paper.

3155.3 Other Protection

Grounding Transformer Applications and Associated Protection Schemes, E.R. Detjen and K.R. Shah, IEEE Trans. on Industry Applications, Vol. 28, No. 4, 1992, p 788-96. The paper reviews the state of the art of grounding transformers and then discusses two case studies illustrating improperly applied grounding transformers and/or associated ground-fault protection schemes. The paper stresses that a single grounding transformer is not adequate for use with a multibus configuration. A protection scheme for use on a multibus arrangement is also presented.

Microcomputer Based Expert System for Control, Protection and Management of 500 kV AC Air Blast Circuit Breakers, J. Esztergalyos, J.H. Burke, E.O. Schweitzer and L.S. Anderson, CIGRE, Paris, Aug 30-Sep 5, 1992, Paper No. 34-207. The paper describes the operation and logic design of a microcomputer based expert system for control, protection and management of 500 kV air blast circuit breakers. The software logic of the expert system can be modified to protect any type of circuit breaker.

Real-Time Fiber Optic Network for an Integrated Digital Protection and Control System, W.H. Kwon, B.J. Chung, J.W. Park, G.W. Lee and M.C. Yoon, IEEE Trans. on Power Delivery, Vol. 7, No. 1, 1992, p 160-6. A single network structure is investigated which supports both protection and control. Two communication schemes are suggested based on IEEE 802.4 specifications. An allocation method is presented.

A Microprocessor Platform for a Generic Protection System, P.G. McLaren, G.W. Swift, E. Dirks, A. Neufeld, Y. Hu and R.W. Haywood, Trans. CEA E&O Div., Vol. 31, 1992, Paper No. 92-SP-144. The paper looks at two different microprocessor board arrangements which serve as a base for a variety of protection devices. The software can dynamically track the fundamental frequency and compute harmonic components for use in protection algorithms. The paper also provides typical examples.

Realization of End User Controllable Protection Schemes within a Coordinated Substation Control System, K. Sridharan, Trans. CEA E&O Div., Vol. 31, 1992, Paper No. 92-SP-175. The paper describes the hardware and software necessary for realization and implementation of protection schemes which are designed and controlled by protection engineer.

Frequency Trend and Discrete Underfrequency Relaying Practice in India for Utility and Captive Power Applications, P.V. Subramanian, M. Viswanathan and V.T. Kairamkonda, IEEE Trans. on Power Delivery, Vol. 7, No. 4, 1992, p 1878-84. The paper discusses the application of frequency trend and underfrequency relays for load shedding for a utility and islanding strategy for a captive power plant.

Interaction of Machine and Line Protection within a Coordinated Substation Control System, H. Ungrad and K.P. Brand, IEEE Trans. on Power Systems, Vol. 7, No. 2, 1992, p 921-925. The paper describes a Substation Control System which coordinates the control and protection functions and provides facilities to protect machines against damage when faults occur in the HV network near the station. Basic structure of the control system and examples are presented.

Short Time Measurement of Frequency and Amplitude in the Presence of Noise, A.M. Zayezdny, Y. Adler and I. Druckmann, IEEE Trans. on Instrumentation and Measurement, Vol. 41, No. 3, 1992, p 397-402. A method for the measurement of amplitude and frequency of sinusoidal signals in the presence of noise is proposed in the paper. Results demonstrating the performance of the proposed method are also included.

3156 FAULT AND SYSTEM CALCULATIONS

Seen Impedance by Impedance Type Relays During Sequential Disturbances, M.M. Elkateb, IEEE Trans. on Power Delivery, Vol. 7, No. 4, 1992, p 1946-54. The trajectory of impedance seen by impedance relays during sequential disturbances is investigated. The case of simultaneous faults is also studied. The analysis is in the phase coordinate frame of reference which provides machine time variant parameters producing a time variant E.M.F.

Effects of Frequency Dependence and Line Parameters on Single Ended Travelling Wave Based Fault Location Schemes, G.B. Ancell and N.C. Pahalawatha, IEE Proceedings-C, Vol. 139, No. 4, 1992, p 332-42. The paper describes the effects of frequency dependence, line asymmetry and varying ground conductivity on ultra high-speed single-ended travelling wave-based transmission line protection and fault location schemes.

A Fault Location Technique for Two and Three-Terminal Lines, A.A. Girgis, D.G. Hart and W.L. Peterson, IEEE Trans. on Power Delivery, Vol. 7, No. 1, 1992, p 98-107. The method described is based on digital computation of current and voltage phasors at the line terminals. The method is independent of fault type, insensitive to source impedance, transpositions, and fault resistance. Test results showed less than 1% error.

Fault Location Techniques for Radial and Loop Transmission Systems Using Digital Fault Recorded Data, A.A. Girgis and C.M. Fallon, IEEE Trans. on Power Delivery, Vol. 7, No. 4, 1992, p 1936-45. This paper shows the conversion of the data to data files and techniques developed to determine fault location. Loads and their effect are discussed. A test case is presented for a loop system; use is made of three phase current & voltage phasors rather than sequence components.

An Application of Functional Dependencies to the Topological Analysis of Protection Schemes, L. Jenkins, H.P. Khincha, S. Shivakumar and P.K. Dash, IEEE Trans. on Power Delivery, Vol. 7, No. 1, 1992, p 77-83. The paper describes algorithms for the identification of a break point set of relays for computer aided setting. Functional dependency forms the basis of identifying a minimal break point set, and selecting a relative sequence matrix.

Fault Identification in an AC-DC Transmission System Using Neural Networks, N. Kandil, V.K. Sood, K. Khorasani and R.V. Patel, IEEE Trans. on Power Systems, Vol. 7, No. 2, 1992, p 812-9. The paper explores the possibility of using neural networks to identify faults in an ac-dc power system. Three different neural network architectures are proposed and a comparison between them is made.

Real-Time Expert System for Fault Location on High Voltage Underground Distribution Cables, K.K. Kuan and K. Warwick, IEE Proceedings-C, Vol. 139, No. 3, 1992, p 235-40. The development of a prototype real-time expert system for locating cable faults is described in the paper. Results from the prototype demonstrate the feasibility and benefits of the expert system.

Development of Advanced Transmission Line Fault Location System, Part 1: Input Transducer analysis and Requirements, D.J. Lawrence, L.Z. Cabeza and L.T. Hochberg, IEEE Trans. on Power Delivery, Vol. 7, No. 4, 1992, p 1963-71. Computer simulation of ct and ccvt transient responses showed that the burdens of additional electromechanical relays caused unacceptable transient distortion of current waveforms for some fault cases. The reduced burden of electronic relays permitted satisfactory results.

Development of Advanced Transmission Line Fault Location System, Part 2: Algorithm Development and Simulation, D.J. Lawrence, L.Z. Cabeza and L.T. Hochberg, IEEE Trans. on Power Delivery, Vol. 7, No. 4, 1992, p 1972-83. This paper describes the solution techniques, system modeling considerations, and simulation studies performed in developing the fault location system. The impact of various system models, hardware features, and system conditions on fault location accuracy was investigated.

Integrated Coordination and Short Circuit Analysis for System Protection, R. Ramaswami and P.F. McGuire, IEEE Trans. on Power Delivery, Vol. 7, No. 3, 1992, p 1112-20. In 1986, work began on Computer-Aided Protection Engineering (CAPE) system. This paper focuses mostly on the Coordination Graphics module and its computational engine, the Short Circuit module. Graphical coordination analysis techniques are described.

A New Approach for Fault Location Problem on Power Lines, A.M. Ranjbar, A.R. Shiram and A.F. Fathi, IEEE Trans. on Power Delivery, Vol. 7, No. 1, 1992, p 146-51. This paper suggests a new technique based on the distributed model of transmission lines to overcome the problems of other approaches. This method considers the effect of capacitance explicitly and enables greater accuracy.

Methods and Uses of Precise Time in Power Systems, R.E. Wilson, IEEE Trans. on Power Delivery, Vol. 7, No. 1, 1992, p 126-32. This paper briefly describes worldwide standard times, practical methods of transferring time from government standards agencies to the utility user, applications, and utility experience with equipment in substations and control centers.

3157 MAINTENANCE, TESTING, ANALYSIS AND MODELING

Power Simulation: A High Power Amplifier Approach, M.G. Adamiak, G.E. Alexander and J.G. Andrichak, 46th Annual Georgia Tech Protective Relaying Conference, Apr 29-May 1, 1992. New high power amplifier technology provides more versatility and dynamic range to cover the diversity of relay test environments. This paper discusses a model power system that uses this technology and presents some examples of simulations performed.

Digitally Simulated Test Performance of Pramod Scheme for UHS Protection of EHV Transmission Lines, P. Agrawal, IEEE Trans. on Power Delivery, Vol. 7, No. 3, 1992, p 1148-55. The paper describes the digital simulation technique for the signal processing of the Pramod scheme and studies the test performance for satisfactory operation under different fault conditions.

Advanced Protection Models for Power System Operation and Maintenance, A. Bueno, L. Carmena, S. Marin, M. Agrasar, J.F. Minambres, J. Ruiz, J. Amantegui and R. Criado, CIGRE, Paris, Aug 30-Sep 5, 1992, Paper No. 34-103. The paper describes the development and application of a set of protection simulation models. Based on these models, query, monitoring and diagnostic functions are developed for system operation, protection maintenance and fault analysis environments.

A Knowledge-Based System for Automatic Evaluation of Disturbance Recordings, L. Cederblad and P.O. Gjerde, CIGRE, Paris, Aug 30-Sep 5, 1992, Paper No. 34-204. The paper describes a system for the automatic evaluation of disturbance recordings. The system consists of decentralized knowledge-based systems in substations and a central system for a disturbance data base. The report from the analysis consists of fault type, fault current and relay operating time etc.

Modelling Overcurrent Relay Characteristics., S. Chan and R. Maurer, IEEE Computer Applications in Power, Vol. 5, No. 1, 1992, p 41-5. The paper reviews the existing methods of modelling overcurrent relay characteristics and describes a new way of creating and editing time-current characteristics. Computer implementation of the proposed method is also given.

Recording and Analysis System is Flexible and Powerful, D. Chermel, Transmission and Distribution, Vol. 43, No.12, 1991, p 40-3. State of the art digital recorder is used to monitor distribution circuits, to allow better load balancing, investigation of circuit fluctuations, and load growth analysis.

Adaptive Analogue Network for Real-Time Estimation of Basic Waveforms of Voltages and Currents, A. Cichocki and T. Lobos, IEE Proceedings-C, Vol. 139, No. 4, 1992, p 343-50. An algorithm for estimation of parameters of a sine-wave, distorted by DC exponential signal and corrupted by noise, is proposed in the paper. The implementation of the algorithm by an adaptive analogue circuit is given. Computer simulation results are also included.

Protection Testing and Maintenance Practices in Ontario Hydro, G.O. Davidson, Trans. CEA E&O Div., Vol. 31, 1992, Paper No. 92-SP-145. The paper describes maintenance practices associated with bulk power protection systems in Ontario Hydro. A brief discussion of the future protection systems and associated maintenance practices is also included.

An Expert System Approach for Protection Engineering, H.E. Dijk, C.J. Van De Water and C.B. Van De Touw, CIGRE, Paris, Aug 30-Sep 5, 1992, Paper No. 34-205. This paper describes the use of expert system methodology for protection engineering. Coordination in radial and meshed power systems is considered.

Acquisition and Statistical Analysis of Protection Devices and Automatic Reclosers Operating Data, G. Dotlic, M. Petkovic, G. Paskota and M. Mitrovic, CIGRE, Paris, Aug 30-Sep 5, 1992, Paper No. 34-106. The paper describes acquisition and analysis of data relating to operation of protective devices and automatic reclosers in electric power industry of Yugoslavia. A system for acquiring and analysing data is also presented.

Design for the Lifetime Management of Protection Systems, J.A. Downes and W.J. Laycock, CIGRE, Paris, Aug 30-Sep 5, 1992, Paper No. 34-107. The paper describes various aspects of relay

and circuit design to reduce the need for routine maintenance and also to provide for efficient and safe testing. Methods and means for protective equipment design which caters for lifetime management are discussed.

Effect of Voltage Harmonics on the Operation of Solid-State Relays in Industrial Applications, A.A. Girgis, J.W. Nims, J. Jacomino and A. Bishop, IEEE Trans. on Industry Applications, Vol. 28, No. 5, 1992, p 1166-73. The paper presents the results of a study on the effects of voltage and current harmonics on the operation of four types of solid-state relays used in control schemes of many industrial applications. Conclusions and recommendations to reduce the impact of harmonic distortion on these types of relays are reported.

COMTRADE: New Standard for Common Format for Transient Data Exchange, IEEE Committee Report, IEEE Trans. on Power Delivery, Vol. 7, No. 4, 1992, p 1920-6. This paper describes IEEE Standard C37.111 for application to digital computer based relays, fault recorders, or digital simulation programs using transient data from electric power systems.

Protective Relaying Performance Reporting, IEEE Committee Report, IEEE Trans. on Power Delivery, Vol. 7, No. 4, 1992, p 1892-9. The paper introduces a computer data base program to organize the relay failure data gathering process, allowing consistent and clearly defined categorization of the data so that interpretation or statistical analysis is easily derived. Potential uses of the data are discussed.

Service Experience and Field Tests Summarizing the Protection and Control Devices Improvement in EHV-UHV Transmissions, V.V. Ilyinichnin, K.V. Khoetsian, V.F. lachugin, A.I. Leviush, V.S. Rashkes, V.N. Sedunov, V.M. Strelkov and G.G. Fokin, CIGRE, Paris, Aug 30-Sep 5, 1992, Paper No. 34-102. The paper discusses the statistical performance data of protection and control devices. Typical test examples of using performance data and results of network test analysis to improve the reliability of protection and control devices are given.

Real-time Monitor Provides Predictive Transformer Maintenance, P. Irwin, Electric Light and Power, Vol. 70, No. 5, 1992, p 27-8. Real-time computer based diagnostic system monitors oil moisture, combustible gas, top oil temperature, primary current and accoustic energy to predict transformer performance and prevents failure.

Deterministic and Stochastic Petri Net Models of Protection Schemes, L. Jenkins and H.P. Khincha, IEEE Trans. on Power Delivery, Vol.7, No. 1, 1992, p 84-90. Protection schemes are modeled through Petri Nets for performance evaluation. Stochastic petri nets enable evaluation of probabilistic performance measures.

DYNA-TEST Simulator for Relay Testing Part II: Performance Evaluation, M. Kezunovic, A. Abur, L. Kojovic, V. Skendzic, H. Singh, C.W. Fromen and D.R. Sevcik, IEEE Trans. on Power Delivery, Vol. 7, No. 3, 1992, p 1097-1103. The paper discusses the modeling of the HL & P system and validation of the CT, PT, & CVT models. Simulated fault data, both primary and secondary of modeled instrument transformers, are compared with actual DFR recorded data.

Development of an Expert System for Estimating Fault Section in Control Center Based on Protective System Simulation, T. Kimura, S. Nishimatsu, Y. Ueki and Y. Fukuyama, IEEE Trans. on Power Delivery, Vol. 7, No. 1, 1992, p 167-72. The paper describes an expert system which estimates the fault section (location) by inferring dynamically the protective coordination of the protective relays. The inference process is displayed in a user friendly manner.

Detailed Analysis of the Performance of Protective Devices in View of a More Effective Protection System, P. Lienart and F. Wellens, CIGRE, Paris, Aug 30-Sep 5, 1992, Paper No. 34-101. The paper describes the philosophy and methods used to obtain a high performance protective system for the Belgian high voltage network. The philosophy involves examining the performance of protective devices in the network and in the laboratory during approval tests.

Management and Service Experience with Numerical Relays in Transmission Systems, M. Mainka, H. Hupfauer, G. Koch and H.D. Michaelis, CIGRE, Paris, Aug 30-Sep 5, 1992, Paper No. 34-108. This paper reports on the experience of three utilities with the microprocessor-based relays. Application practices and operating performances are reviewed.

Performance of Distance Relay MHO Elements on MOV-Protected Series-Compensated Transmission Lines, R.J. Marttila, IEEE Trans. on Power Delivery, Vol. 7, No. 3, 1992, p 1167-78. Both the MOV and the air gap, when conducting, change the line impedance as seen by the distance relays. This paper discusses the findings of a study on the effect to direct under-reach/permissive overreach protection schemes with 65% line impedance compensation.

Experience With Maintenance and Improvement in Reliability of Microprocessor-Based Digital Protection Equipment for Power Transmission Systems, T. Matsuda, J. Kobayashi, H. Itoh, T. Tanigushi, K. Seo, M. Hatata and F. Andow, CIGRE, Paris, Aug 30-Sep 5, 1992, Paper No. 34-104. The paper describes the software and hardware failures in microprocessor-based protection equipment. Various countermeasures to prevent these failures are also discussed.

A Real Time Digital Simulator for Testing Relays, P.G. McLaren, R. Kuffel, R. Wierckx, J. Giesbrecht and L. Arendt, IEEE Trans. on Power Delivery, Vol. 7, No. 1, 1392, p 207-13. The paper describes the structure and performance of a digital simulator for testing relays. A signal processor with parallel processing runs power system simulations in real time with a time step of 50-100 μs. Test examples for a commercial distance relay are given.

Differential Relay Transient Testing Program Using EMTP Simulations, G.D. Rockefeller, L. Lawhead, T. Wilkerson, J. Biggs, 46th Annual Georgia Tech Protective Relaying Conference, Apr 29-May 1, 1992. A critical step in the verification of a relay design is transient testing. This paper discusses the procedure that was initiated by one utility on their transformer and generator differential relays.

Protection of Series Compensated Transmission Lines - Modelling and Appraising, M.S. Sachdev and L.R. Tumma, Trans. CEA E&O Div., Vol. 31, 1992, Paper No. 92-SP-183. An enhanced steady state representation for modelling series capacitors protected by metal oxide varistors is developed. Based on the model, an algorithm is proposed for a digital distance relay to protect series compensated transmission lines. The ability of the algorithm is checked using data obtained from computer simulations.

Testing of Series-Compensated Line Protection System With Telecommunications, A. Sauve, M. Le-Quang and A. Lavallee, Trans. CEA E&O Div., Vol. 31, 1992, Paper No. 92-SP-158. The paper describes the test setup and tests conducted to check the

performance of a current-differential protection system for protecting series-compensated lines. The test results, conclusions drawn from them and future testing are also discussed.

Probabilistic Investigations on Bit Error Ratio Requirement for Digital Teleprotection Employing Digital Microwave Links, Y. Serizawa, E. Ohba and A. Tsuboi, IEEE Trans. on Power Delivery, Vol. 7, No. 1, 1992, p 202-6. The paper describes a bit error ratio requirement for a PCM current differential protection system using digital microwave. Relay down-time ratio due to errors is evaluated and discussed.

A Computer-Aided Design Tool for Developing Digital Controllers and Relays, T.S. Sidhu, M.S. Sachdev and H.C. Wood, IEEE Trans. on Industry Applications, Vol. 28, No. 6, 1992, p 1376-83. Design, development and implementation of a computer-aided design (CAD) tool for developing digital controllers and relays is presented in this paper. Application of the CAD tool is demonstrated by evaluating and comparing three different designs of a digital overcurrent relay. The paper also describes the algorithm used in the relay design.

Experience of Protection Equipment Maintenance - A Case Story, B. Svensson, G. Mathiasson, S. Holst and S. Lindahl, CIGRE, Paris, Aug 30-Sep 5, 1992, Paper No. 34-105. The paper describes the experience of Sydkraft, a Swedish electric power company, in maintenance of protection equipment. The experience from maintenance and operation of protective equipment is used for analysing their reliability and for formulating future maintenance policy.

Development of Fault Characterization Equipment (FCAREC) for Power Transmission Lines, K. Tsuji, H. Yanagida, H. Sasaki and S. Abe, IEEE Trans. on Power Delivery, Vol. 7, No. 1, 1992, p 133-8. This paper presents fault characterization equipment which detects fault resistances in a time sequence, and fault location. The objective is to offer improved functions to estimate the causes of system faults.

3158 STABILITY, OUT OF STEP, RESTORATION

An Adaptive Method for Setting Underfrequency Load Shedding Relays, P.M. Anderson and M. Mirheydar, IEEE Trans. on Power Systems, Vol. 7, No. 2, 1992, p 647-53. The paper proposes an adaptive methodology for determining the amount of load to be shed by underfrequency relays. The method is based on the observed initial rate of change of frequency at the relay.

A Generation Shedding Scheme for the Jim Bridger Steam-Electric Plant, C.E. Charman and J.W. Littman, 19th Annual Western Protective Relay Conference, Oct 20-22, 1992. Discussed is a scheme used to shed quickly a block of generation on the loss of critical transmission ties. The benefits of such a scheme are higher generation and transfer levels without loss of system stability.

Single Phase Tripping and Auto Reclosing of Transmission Lines, IEEE Committee Report, IEEE Trans. on Power Delivery, Vol. 7, No. 1, p 182-92. The benefits of application, relaying techniques, performances, and statistics are discussed. The paper covers system stability, single-phase tripping and reclosing schemes, and methods of secondary arc extinction.

Microprocessor-Based Load Shedding Keeps Industry Systems in Balance, C. St. Pierre, IEEE Computer Applications in Power, Vol. 5, No. 1, 1992, p 21-4. The paper describes the structure and operation of a computer-based load shedding system. Flexibility, increased speed and minimum load shed are possible. Performance comparisons are made with the under-frequency load shedding method.

Undervoltage Load Shedding an Ultimate Application for Voltage Collapse, H.M. Shuh and J.R. Cowan, 46th Annual Georgia Tech Protective Relaying Conference, Apr 29-May 1, 1992. Voltage instability has caused considerable concern among utilities and the power industry. This paper presents an undervoltage load shedding scheme designed to prevent a total area blackout from a voltage collapse in a specific area.

Reclosing Practices, F. Soudi and E.A. Taylor, 19th Annual Western Protective Relay Conference, Oct 20-22, 1992. The reclosing philosophies of PG&E are discussed. The continued use of the latest technology and the use of existing SCADA software allow utilities to develop a more intelligent means of reclosing for meeting the demands of quality service to the customer.

Concepts of Undervoltage Load Shedding for Voltage Stability, C.W. Taylor, IEEE Trans. on Power Delivery, Vol. 7, No. 2, 1992, p 480-8. This paper discusses the effects of different load characteristics on many considerations for undervoltage load shedding. These considerations lead to specific requirements for undervoltage load shedding schemes.

Islanding Problems for Non-Utility Generation, C.L. Wagner, 45th Annual Texas A&M Protective Relay Conference, Apr 13-15, 1992. The interconnection of non-utility generation to the utility transmission and distribution circuits has added a new complication to the design of the utility systems. This paper discusses some of these concerns.

3159 SURGE PHENOMENA

Tightening Surge Testing Procedures - Problems and Solutions, R.P. Heller, 45th Annual Texas A&M Protective Relay Conference, Apr 13-15, 1992. New standards have been put in place recently that change the way equipment is designed and tested. This paper reviews surge standards and provides a comparison of one to another. The problem of which standard to apply is examined and solutions are offered.

Impact of Electromagnetic Compatibility Requirements on the Design and Maintenance of Protection and Control Equipment, E.P. Walker, Trans. CEA E&O Div., Vol. 31, 1992, Paper No. 92-SP-177. The paper describes the generation of electromagnetic disturbances in the protection relay environment and discusses ways to overcome the effects of these disturbances with regard to protection system in its operational environment. A resume of the international standard's position with regard to electromagnetic compatibility as related to protection systems is also included.

LIST OF PERIODICALS

IEEE Transactions, Journal and Conference Papers
IEEE Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331

ABB Review
ABB Marketin Services Ltd., P.O. Box 58, Baden, CH-5401, SWITZERLAND

Canadian Electrical Association - Trans. of the Eng & Oper. Division
Suite 1600, 1 Westmount Square, Montreal, PQ H3Z 2P9, CANADA

CIGRE
3-5 rue de Metz, F75010, Paris, France

Electric Light and Power
Technical Publishing Co., 1301 South Grove Ave., Barrington, IL 60010

Electric Construction and Maintenance
McGraw Hill Publishing Co., 1221 Avenue of the Americas, New York, NY 10020

Electric Power System Research
Elsevier Sequoia S.A., P.O. Box 564, Lausanne, CH-1001, SWITZERLAND

Electrical Review
Reed Business Publishing, Central House, 27 Park Street, Croyden, CRO 1YD, U.K.

Electrical World
11 West 19th Street, New York, NY 10011

Engineering Institute of Canada - Journal of the Can Soc for Elec& Comp Eng
Suite 700, 2050 Mansfield Street
Montreal, PQ H3A 1Z2, CANADA

Ga. Tech Protective Relaying Conference
Georgia Institute of Technology, Atlanta, GA 30332

IEE Proceedings
Institute of Electrical Engineers; Michael Faraday House, Six Hills Way, Stevenage, Herts SG1 2AY, U.K.

Power
McGraw Hill Publishing Co., 1221 Avenue of the Americas, New York, NY, 10020

Texas A&M Protective Relaying Conference
Texas A&M University, College Station, TX, 77843

Transmission and Distribution
Intertec Publishing Inc., 5072 West Chester Pike, Edgemont, PA, 19028

Western Protective Relaying Conference
Washington State University, Pullman, WA, 99163