ABSTRACT

The latest of a series of classified lists of power system relay literature 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:

1927-1939, Vol. 60, p 1435-1447
1940-1943, Vol. 61, p 705-709
1965-1966, Vol. PAS-88, No. 3, p 244-250
1978-1979, Vol. PAS-102, No. 5, p 2407-2415

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 brief subject summary of the subject matter.

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

The listing of the titles is subdivided into 10 sections, depending upon the general substance of each article. The section titles are as follows:

3150 COMPUTER RELAYING
3151 DISTRIBUTION AND NETWORK PROTECTION
3152 TRANSMISSION LINE PROTECTION
3153 RELAY INPUT SOURCES
3154 ROTATING MACHINERY PROTECTION
3155 OTHER PROTECTION
3156 FAULT AND SYSTEM CALCULATIONS
3157 TESTING AND ANALYSIS
3158 STABILITY, OUT OF STEP, RESTARTION
3159 SURGE PHENOMENA


BIBLIOGRAPHY OF Relay LITERATURE, 1988-1989
IEEE COMMITTEE REPORT


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 various sections. A list of the periodicals which have been cited and their place of publication follows the bibliography.

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.

Computer Relaying for Power Systems, Arun G. Phadke and James S. Thorp, Research Studies Press Ltd., Taunton, Somerset, England, and John Wiley & Sons Inc., New York, 1988. This book presents the basics of computer relaying principles and their applications for transmission line, transformer, machine, and bus, protection. Aspects of integrated substation protection and control are also included. Newer relaying principles, such as travelling wave relays and adaptive relaying, are also discussed.

Microprocessor Relays and Protection Systems, M.S. Sachdev (Coordinator), Tutorial Text, Pub. No. 0897925-1-PWR, New York, 1988. This book was prepared in continuation to the previous tutorial text, "Computer Relaying". The information on the subjects of digital relaying hardware and algorithms is updated. Also discussed are the subjects of protection functions, relaying in an integrated hierarchical system, background tasks, and travelling wave relays. Some commercially available relays are also described.

3150 COMPUTER RELAYING

Utilities Move to Digital Relays - But Cautiously, Electrical World, Vol. 202, No. 2, Dec. 1988. Protection engineers are asking about chips and software and even scrutinizing the manufacturers' acceptance tests to make sure they know what they are buying.


An Adaptive Sampling-Interval Generator for Digital Relaying, G. Beramoyal, IEEE Trans. on Power Delivery, Vol. 4, No. 3, July 1989, p 1602-9. This paper presents the basic principle of an adaptive sampling-interval generator which locks to the fundamental frequency component of the incoming signal. An application of this principle to a Volta- per-Hertz relay is described.

Programmable Controllers Quietly Enter Substations, Martin Best, Electric Power and Light, Vol. 66, No. 12, Dec. 1988, p 31, 34. This paper describes the use of programmable controllers or programmable logic controllers (PLC's) as a reliable and cost effective means of designing and implementing relay and control systems for electric power substations.
Extensive Testing of Algorithms for Travelling-Wave Based Protection, M.H.J. Bollen, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989, p 135-139. This paper details the performance of travelling wave algorithms using data generated by the EMT and TWNPIL - Travelling Waves On Non-balanced Frequency-Independent Transmission Lines programs. Line faults, lightening strokes and line energization are considered.

Development of Custom LSIs for Protective Relays and Their Evolution to New Static Relays, T. Ohts, H. Kudo, A. Watanabe, H. Goto and K. Sato, IEEE Trans. on Power Delivery, Vol. 3, No. 1, Jan. 1988, p 130-7. This paper describes the features of the LSJ circuits and the key technologies used to develop high performance relays. Performance tests of prototype relays are also included. Problems solved include wide input range, precise analog operation with no manual adjustment, whole electronic circuits on a single chip, standardization, and low power dissipation.


Digital Station Protection, D. Cramer, K.P. Brand, H. Hager and J. Kopaisluky, IEEE Trans. on Power Delivery, Vol. 4, No. 3, July 1989, p 1617-24. This paper presents a microprocessor based approach for protecting all units in a substation. The processing units are located at each protection zone boundary. Fault type and direction are evaluated from current and voltage phasors. Trip output is produced by a collective decision of all processing units. The structure allows flexibility, reliability, and maintainability.

A Simplified Algorithm for Digital Distance Protection Based on Fourier Techniques, D. D’Amore and A. Ferrero, IEEE Trans. on Power Delivery, Vol. 4, No. 1, Jan. 1989, p 157-64. A new approach based on a variable frequency sampling technique is proposed. It is shown that the technique performs like other Fourier-series algorithms under typical fault conditions but the computation burden is reduced.


Developments in Distance Protection, P. Dodds, 4th Int. Conf. on Developments in Power System Protection, IEEE Pub. No. 302, 1989, p 205-9. A method for decreasing the comparator operating time in a distance relay is discussed in this paper.

Off-Nominal Frequency Measurements in Electric Power Systems, H.M. Grat and M.S. Sachdev, IEEE Trans. on Power Delivery, Vol. 4, No. 3, July 1989, p 1573-8. The paper presents a technique that estimates frequencies in the 20 to 80 Hz range from sampled values. The technique uses the Least Error Squares approach to extract the information from the measured values of the samples.


A Hybrid Expert System for Faulted Section Identification, Fault Type Classification, and Selection of Fault Location Algorithms, A.A. Giris and R.B. Johns, IEEE Trans. on Power Delivery, Vol. 4, No. 2, Apr. 1989, p 978-85. This paper describes an expert system to identify faulted sections and interpret relay operations in an interconnected power system. The system measures current and voltage phasors to classify the type of a fault and compute its location.


Microprocessor-Based Auto Synchronizer for the CEB's Transmission System, J.V. Hughes and B.R. Jakeman, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989, p 281-5. This paper presents the specifications, electrical interference characteristics and technical aspects of a microprocessor-based synchronizer developed for the CEB's transmission system. The operation of the autosynchronizer is also outlined.


Digital Protective Relaying Through Recursive Least-Squares Identification, A. Isakson, IEE Proceedings-C, Vol. 135, No. 5, Sept. 1988, p 441-9. The recursive least-squares algorithms described in this paper and are applied to the estimation of Fourier coefficients of voltages and currents. The estimates are used to detect the presence of line short circuits. Some results obtained by using data from the EMT program are presented.

Adaptive Transmission Protection: Concepts and Computational Issues, A.K. Jampala, S.S. Venkata and M.J. Damborg, IEEE Trans. on Power Delivery, Vol. 4, No. 1, Jan. 1989, p 177-85. This paper describes the basis for an adaptive transmission protection, defines the concept, identifies its components, and illustrates it with simple examples. Efficient enhancement to existing off-line algorithms used in relay coordination are presented. Two computing approaches are investigated for developing an on-line tool for computing relay settings in real-time.


Modern Practices and Field Experience With MC-Based Relays, G. Koch and G. Ziegler, 4th Intl. Conf. on Development in Power System Protection, IEEE Pub. 302, 1989, p 315-20. This paper briefly outlines the protection concepts used in MC-based relays. Three concepts are developed from field experience and recommendations of the Association of German Power Supply Authorities.


Fast (1-Shift) Orthogonal Functions for Extraction of the Fundamental Frequency Component for Computer Relaying, V.D. Patilakar, Electric Power Systems Research, Vol. 14, 1988, p 233-6. Digital relays extract the fundamental frequency components from distorted post-fault voltages or currents using either Fourier, Walsh, or Haar algorithms. This paper describes a new set of odd/even orthogonal functions and compares its performance with other methods with respect to computational speed and frequency response.

Computer Relaying: Its Impact on Improved Control and Operation of Power Systems, A.G. Phadke, IEEE Computer Applications in Power, Vol. 1, No. 4, Oct. 1988, p 5-10. This paper describes a hierarchical system of computers which can provide relaying, and direct access to relays, control devices, and measuring systems throughout the power system.


Ultra High Speed Directional Comparison Relay for EHV and Lines, K.S. Prakash, O.P. Malik and G.S. Hope, Trans. CEA EAO Div., Vol. 26, Part 4, 1987, Paper No. 87-SR-168. This paper describes an ultra high speed directional comparison relay which is based on the quasi steady state components of the locally measured deviations of voltages and currents from their prefault values.

The Protection of Circuit Breakers from Excessive Duty Using Digital Techniques, D.A. Pritchard, R.P. DeFay and W.R. Tyska, 43rd Annual GA Tech Protective Relaying Conference, 1989. This paper discusses the concept of a breaker reclosing relay that limits the number of close operations to avoid excessive circuit breaker duty during repetitive operations.

Adaptive Transmission Relaying Concepts for Improved Performance, C.L. Routbort, B.J. Linders, W.J. Hicks and D.T. Risig, IEEE Trans. on Power Delivery, Vol. 3, No. 4, Oct. 1988, p 1446-58. Adaptive concepts include on-line changes in relay settings, relay characteristics, or logic in response to power system or environmental changes. It is shown that adaptive relaying is capable of improving relaying reliability and power system security, and makes better utilization of the facilities.

A Digital Technique for Estimating Frequency from Sampled Values of a Voltage, N.S. Sachdev and B. Chattopadhyay, Trans. CEA EAO Div., Vol. 27, Part 4, 1988, Paper No. 88-SR-158. The technique estimates the angle between voltage phasors at two instants of time and estimates the frequency from the phase measurements. The results presented in the paper show that the technique is suitable for use in microprocessor based relays.

A Non-Linear Modelling Approach for Detecting Winding Faults in Power Transformers, N.S. Sachdev, T.S. Sidhu and H.C. Wood, Trans. CEA EAO Div., Vol. 28, Part 4, 1989, Paper No. 89-SR-142. This paper presents two versions of a digital algorithm that detects winding faults in single and three phase transformers. The algorithm is based on a non-linear model of the protected transformer. A variety of operating conditions simulated on a computer are used to test the algorithms.


87CH2499-2, Part II, 1987, p 1744-9. This paper demonstrates the application of virtual digital relays as computer-aided design tools. Three different designs of a digital overcurrent relay are evaluated and compared.

Distance Digital Algorithm Immune to Saturation of Current Transformers, A. Wissinowski and J. Szirmai, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989, p 196-9. A digital distance relay algorithm which is not affected by ct saturation is described in this paper. The algorithm avoids the effect of ct saturation by calculating the current phasor only in the intervals when cts are not saturated.

Fault Tolerant Microcomputer Design for Power System Applications, H.C. Wood and A.D. Jalapapkar, IEEE Div., Vol. 26, Part 4, 1989, Paper No. 89-SF-145. This paper describes a design for a triple modular redundant microcomputer-based system. Results are given for a laboratory prototype built to demonstrate the design principles.

Tools for Computer-Aided Development of Microprocessor Based Power System Relays, H.C. Wood, M.S. Sachdev and T.S. Sidhu, Annual General Meeting of the IEEE Industry Application Society, Pub. No. 87CH2499-2, Part II, 1987, p 1733-8. This paper describes the design, development and implementation of virtual digital relays that can be used to examine the feasibility of a relay design. Procedures for modeling A/D converters and simulating the relay software are presented.

3151 DISTRIBUTION AND NETWORK PROTECTION

An Assessment of the Performance of Distance and IDMT Overcurrent Relays for Phase Faults on Interconnected Power System Networks, H.A. Abyanneh and D. Lidgate, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989, p 291-5. An algorithm to assess the performance of distance and IDMT overcurrent relays is presented in this paper. The algorithm is implemented in Fortran V and the test results from its application are presented.

3151.1 INDUSTRIAL AND POWER STATION AUXILIARY SYSTEMS

Improved Microprocessor Based Distribution Feeder Earth Fault Protection Using Pattern Recognition, M. Al-Dabbagh, R. Daoud and R. Coulter, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989, p 113-5. This paper describes a relay that detects earth faults on a three wire underground distribution system. Patterns of voltages and currents during faults are used to identify faults.

Integrated Protection and Control Digital System for Rural Substations, E. Bondia, E. Suarez and F. Oubel, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989, p 121-6. This paper describes the functions performed by an overcurrent relay which also performs measuring and control functions. The relay can communicate with remote locations through an RS-232 port.

Automatic Earth Fault Isolation and Restoration of Supply in Cable Distribution Networks, K. Brown, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989, p 271-5. This paper describes the hardware and application of an automated unit for isolating earth faults and restoring supply in cable distribution networks. The application is discussed in three steps, fault section identification, sectionalization and restoration by reconfiguring the system.

Transfer Switching Without Interruption, R. Casten- schold, Electrical Construction and Maintenance, Vol. 87, No. 9, Sept. 1988, p 71-5. Closed-transition transfer eliminates problems caused by momentary loss of power from open-transition transfer to or from a standby or emergency source. Most existing transfer switches are the open-transition type. An economical solution consists of adding two magnetically held contactors to parallel the switch momentarily. Operations with motor loads and power failures are discussed.

Requirements for Coageneration in Parallel with the Utility, J.M. Daley, Electrical Construction and Maintenance, Vol. 87, No. 4, Apr. 1988, p 63-9. Coageneration is most energy-efficient when generating in parallel with the utility, but requires proper controls and protection. Typical protective systems for these generators are discussed. Engine and generator operation and system grounding requirements are also outlined.

Microprocessor Based Integrated Feeder Protection RIR 2000, D. Kocznik, J. Ruger, B. Suhl and J. Gorisek, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989, p 286-90. This paper describes the hardware and software of a microprocessor-based integrated feeder protection for distribution networks. The system includes three-phase overcurrent and one earth-fault relays.

Development of an Expert System for Power System Protection Coordination, L.L. Lai, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989, p 310-4. The development of a prototype expert system for coordinating the protection of an industrial power system is presented in this paper. The usefulness of the expert system is demonstrated by applying it to a typical industrial power system.

Considerations for Ground Fault Protection: Medium-Voltage Industrial and Cogeneration Systems, D.J. Love and N. Hashemi, Trans. on Industry Applications, Vol. 24, No. 4, July/Aug. 1988, p 549-55. Typical methods for grounding of industrial medium voltage neutrals - high resistance, low resistance, and ungrounded - as well as methods used to detect the presence of a ground fault are reviewed. The effects of charging currents and the effects of ground fault protection method on conductor ratings are analyzed.

Zone Selective Interlocking Reduces Fault Stress, T.A. Michalak, Electrical Construction and Maintenance, Jan. 1989, p 63-5. The operation of circuit breakers of a low voltage distribution system is coordinated by overcurrent magnitude and time delay. Zone Selective Interlocking (ZSI) of electronic trip units permits instantaneous tripping of the upstream breaker when the downstream breaker senses no fault current.


An Industrial View of Utility Cogeneration Protection Requirements, L.J. Powell, IEEE Trans. on Industry Applications, Vol. 24, No. 1, Jan/Feb 1988, p 75-81. Typical utility requirements for protection at the interface with a cogenerating industrial system are reviewed. The basis for their formulation is explained and practical ways for the industrial cogenerator to satisfy them are suggested.

describes the need for cogeneration/utility interconnection relays and control systems.

3151.2 PRIMARY DISTRIBUTION SYSTEM


Fault Protection Experience on Radial Distribution Circuits Containing Dispersed Storage and Generation (DSG) Units, J.T. Emery, 42nd Annual CA Tech Protective Relaying Conference, 1988. A comparison of the operating experience of distribution circuits with and without DSG's is presented. The comparison serves as a basis for determining the impact that the installation of DSG's have on radial distribution circuit protection.


Distribution System Protection - the Application of Modular Electronic Schemes, K.J. Mackay and A.J. van der Walt, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989, p 91-5. The "Phase 2" of the design and development of a protection system for the South Africa's national electrical power supply utility is described in this paper. This system is for use on lines rated up to 132 kV.


Relaying Protects Automated Distribution Systems, G.E. Meter and Control, Electric Power and Light, Vol. 67, No. 3, March 1989, p 42. This paper describes the technology which includes laying in control and metering systems for distribution automation.


A Microprocessor Protection Relay for Source Protection of 11-kV Radial Distribution - Its Design and Field Trial Experience, G.V. Roberts, I. Trevor, W. Keong and D.T. Vipp, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989, p 80-5. A radial distribution protection relay is described in this paper. The relay includes definite time and inverse time overcurrent and ground fault functions. Another function included in this design is the detection of low levels of currents due to faults on the secondary side of a distribution transformer.

The Development of an Integrated Protection and Reclosing Relay for Rural Feeders, F.R. Rosen, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989, p 278-80. Development and features of an integrated protection and reclosing relay for rural feeders are presented in this paper. The relay is developed for use on rural feeders of the South African Electricity Utility.


Behavior of Low Frequency Spectra During Arcing Fault and Switching Events, B.D. Russell, R.P. Chinchalk and C.J. Rim, IEEE Trans. on Power Delivery, Vol. 3, No. 4, Oct. 1986, p 1485-92. The variation and behavior of selected low frequency components during faults are presented. They are contrasted to normal events such as feeder and capacitor bank switching. Recorded field data is analyzed and presented. Arc duration, arc repetition rate, and magnitude of low frequency spectra are noted.


Overall Assessment of Distribution Backup Protection Using Micro-Computer, C.Y. Teo and T.W. Chan, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989, p 107-12. An interactive package for coordinating inverse time overcurrent relays is described in this paper. The software calculates the fault currents after each change in the system configuration and performs the coordination task. Breaker failure can be simulated.

A Logic Programming Approach to Fault Diagnosis in Distribution Ring Networks, K.P. Wong and C.P. Tsang, Electric Power Systems Research, Vol. 15, 1990, p 77-87. This paper develops the logic for diagnosing faults in distribution ring networks. It is then implemented by a goal-directed language, Prolog.

Application of Digital Filters in Power Systems, H.C. Wood and N.S. Sachdev, IEEE Pacific Rim Conference on Communications, Computers and Signal Processing, Victoria, B.C. Canada, Pub. No. CH2691-4/90-0000, 1989, p 277-80. This paper describes the application of signal processing techniques to power system protection. Signal processing aspects that are unique to fast and real-time operations in electric power systems are discussed.

3151.4 DISTRIBUTION AND NETWORK PROTECTION

Industrial Feeder Protection, G. Fielding and G.W. Evans, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989, p 264-70. This
paper describes practical arrangements for protecting
HV feeders in industrial power systems. The effect of
short-circuits on industrial motors is also discussed.

Computer Assessment of IDMT Relay Performance for
Phase and Earth Faults on Interconnected Power
Systems, D. Lidgate and H. Askarian Abyaneh, IEEE
This paper describes two algorithms for coordinating
IDMT overcurrent relays. One determines the settings
of relays used for detecting phase faults and the
other determines the settings of ground fault relays.

Development of New Protection for Interconnected
Overhead 33 kV Circuits, J.V.M. Sanderson, N.
Kyiakiades, W.J.S. Rogers, G.G. Evans and B.W.
Swinerton, 4th Int. Conf. on Developments in Power
This paper describes a microprocessor based relay for
use on inter-connected 33 kV over-head lines. The
relay includes fault detection, directional
overcurrent and voltage restrained overcurrent
functions. Communications facilities are included to
perform SCADA functions.

3152 LINE PROTECTION

New Approach to Ted Feeder Protection Using Composite
Curves and Voltage Signal Comparison, R.K. Agrawal
and A.T. Johns, 4th Int. Conf. on Developments in
125-9. This paper describes a technique for
protecting three terminal transmission lines. It uses
voltages and currents at the three terminals.

Simplification of Polyphase Line Protection, G.E.
Conf. on Developments in Power System Protection, IEE
Pub. No. 302, 1989, p 192-5. An "energy comparator"
used in GE solid state line protection system (PSS relay system) is described in this paper. Advantages of
using the "energy comparator" for solid state
directional and distance measuring units are outlined.

Differential Line Protection Application to
Multi-Terminal Lines, J. Aborzi, 4th Int. Conf. on
Developments in Power System Protection, IEE Pub.
No. 302, 1989, p 121-5. This paper describes the
functional specifications used in developing a
differential line protection system. The relay has
been tested using a transient network analyser and is
now undergoing site testing in E.D.F.

The Performance of a Protective Scheme Based on
Travelling Waves, C. Christopoulos, D.W.F. Thomas
and A. Wright, 6th Int. Conf. on Developments in Power
The travelling waves principle presented in this paper
estimates the fault resistance and then the fault
location. Sample results are presented.

Experience and Problems With the Protection of Series
Compensated Lines, R.G. Cony, G.H. Topham and W.G.
Fawcett, 4th Int. Conf. on Developments in Power System
the performance of (i) permissive over-reaching and
electromechanical impedance relays, (ii) directional
comparison relays and (iii) phase and ground impedance
protection schemes for series compensated transmission
lines over a period of thirteen years is reported in this paper.

Over and Undervoltage Protection of Weakly
Interconnected HV Loop Line Networks, R.G. Topham
and P.M. Marot, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No.
302, 1989, p 162-5. This paper describes the use of
overvoltage and undervoltage protection principles on
400 and 765 kV lines of Eskom, Republic of South Africa.
Overvoltage relays disconnect the line from
the system. Undervoltage relays initiate load
shedding in the event of loss of interconnection
capacity.

Scheme, Based on Travelling-Waves, for the Protection
of Major Transmission Lines, C. Christopoulos, D.W.F.
1, Jan. 1988, 63-69. The development of the
travelling-wave theory to detect faults on a single
phase line is presented in this paper. The
identification of the incident and reflected
travelling waves is described. The technique is then
applied to three phase systems. Some results from
simulations are presented.

The Design of a Directive Comparison Protection for
HV Transmission Lines, P.A. Crossley, S.F. Elson,
S.J. Rose and A. Williams, 4th Int. Conf. on
302, 1989, p 151-5. A directional comparison relay is
described in this paper. The relay can be used in a
blocking or permissive inter-tripping scheme.

Limits to Zones of Simultaneous Tripping in
Conf. on Developments in Power System Protection, IEE
quantitatively determine the limits to zones of
simultaneous tripping is presented in this paper. The
technique models the relay reach as a function of
system parameters with their associated uncertainties
and uses mathematical programming to determine optimum
relay reach. Simulation results from application to a
130 kV three-terminal line are presented.

Adaptive Digital Distance Protection, P.J. Moore and
A.T. Johns, 4th Int. Conf. on Developments in Power
This paper describes a digital distance relay which
adapts to power system conditions such as power
swings and high-resistance earth faults. Simulation studies
show the relay operation times, high resistance earth
fault coverage and response to power
swings.

Series Compensated Line Protection: System Modelling
and Relay Testing, A. Newboulde and J.A. Taylor, 4th
Int. Conf. on Developments in Power System Protection,
IEE Pub. No. 302, 1989, p 182-6. This paper describes the
application of distance protection to series
compensated lines. The proposed system and tests
conducted in a laboratory using computer generated
signals are described. Voltage and current inversion
phenomena and selection of polarizing voltages are
briefly discussed.

A New Approach to High Speed Relaying Based on
Transient Phenomena, T. Korsjo and B.H. Saks, 4th
Int. Conf. on Developments in Power System Protection,
IEE Pub. No. 302, 1989, p 140-5. This paper describes a
 technique which calculates, from local observations, the
electric potential expected at the remote terminal of a line
if the fault was external. The expected voltage is compared with the observed voltage to decide if the
fault is on the protected line.

A Second Generation Microprocessor Line Protection
Relay, D.R. Flick, F. Engler and I. De Meenaker, 4th
Int. Conf. on Developments in Power System Protection,
IEE Pub. No. 302, 1989, p 200-4. This paper describes the
hardware and software of a microprocessor-based
distance relay for line protection.

Optical Fibre Signalling for Protection Purposes,
W.S. Rogers, G.C.P. Evans, J.B. Bailey and R.W.
Nicholls, 4th Int. Conf. on Developments in Power
brief description of a fibre optic link for the
protection of and communication between two terminals
of a short transmission line is given in this paper.
Setting Distance Relays for Multi-Coupled Lines Using Permissive Underreach Schemes, G. Varga and F. Rodrigues, 4th Int. Conf. on Developments in Power System Protection, IEEE Pub. No. 302, 1989, p 306-9. This paper reviews the problems related to setting of distance relays for lines that have multiple couplings. A method using a permissive underreach scheme is suggested.

Design of a Generic Range of Distance Relays, G.C. Weller, B.B.J. Caunce and N. Robinson, 4th Int. Conf. on Developments in Power System Protection, IEEE Pub. No. 302, 1989, p 210-4. This paper describes the design of a generic range of multiprocessor distance relays. Hardware structure, user interface, measuring units and self-monitoring are discussed.

A Microprocessor Based Current Differential Protection, J.W. Wheatley 4th Int. Conf. on Developments in Power System Protection, IEEE Pub. No. 302, 1989, p 116-20. The functions performed by a current differential relay for line protection are described in this paper. Hardware arrangement for a three terminal application is outlined with the aid of functional block diagrams.

3152.1 DISTANCE AND GROUND RELAYING


Modern Transmission Line Relaying Variations, W.A. Elmore, 43rd Annual GA Tech Protective Relaying Conference, 1989. For many years transmission line relaying variations were limited to simple non-pilot distance, and directional comparison and phase comparison pilot systems. As reliable and diverse communication channels became available, variation of these fundamental systems began to emerge. This paper describes some of the lesser known systems in their simplest form to amplify their strengths and weaknesses.

The Application of High Speed Grounding Switches for Secondary Arc Extinction on HV/EHV Power Lines Control and Protection, J. Estergalgy, S.L. Wiese and S.H. Ahmed, 43rd Annual GA Tech Protective Relaying Conference, 1989. The paper covers such areas as: (i) conventional secondary arc extinction methods on HV/EHV lines with single-pole tripping, (ii) the four reactor scheme and the problems that arise from its application on parallel, untransposed HV/EHV lines with single phase trip, and (iii) specific problems arising from lines terminated in Gas Insulated Substations.


A General Method for the Analysis of Distance Relay Elements, R.J. Martilla, Trans. IEEE E E Div., Vol. 27, Part 4, 1988. A general method for the analysis of the response of distance relay elements is presented. The method calculates the apparent impedance of various types of relay elements from the fault quantities and directly plots on an RV-plane. Computer models of various distance relay elements are presented and examples of their response, as affected by line loading, are highlighted.

Effect of Transmission Line Loading on the Performance Characteristics of Polyphase Distance Relay Elements, R.J. Martilla, IEEE Trans. on Power Delivery, Vol. 3, No. 4, Oct. 1988, p 1466-74. The performance characteristics of a polyphase phase fault detecting element is reported to show the effect of line loading and reach setting on the detection characteristics. The results are presented in a manner that permits ready assessment of the expected performance in a particular application.

Travelling Wave Relays - An Update, P.G. McLaren, Trans. IEEE E E Div., Vol. 28, Part 4, 1989, Paper No. 89-SP-143. This paper describes the travelling wave and ultra high speed relays which are presently available.

Series Compensated Lines: Issues Relevant to the Application of Distance Protection, A. Wachtendorf, 43rd Annual GA Tech Protective Relaying Conference, 1989. The paper describes some of the lesser known systems in their simplest form to amplify their strengths and weaknesses.

Digital Distance Relay with Improved Characteristics Against Distorted Transient Waveforms, T. Draka, T. Matsuda, H. Suzuki, H. Yamaura, V. Rustega, and T. Yokoyama, IEEE Trans. on Power Delivery, Vol. 4, No. 4, Oct. 1989, p 2025-31. Future 1100-kV lines and 500-kV cables will have high capacitive which will lower transient frequencies. A differential equation algorithm, which provides measurement performance with less that 3% error when transient low frequency components are present, is described in the paper.

A Polyphase Digital Distance Relay, K.S. Sachdev and S.R. Kolla, Trans. IEEE E E Div., Vol. 26, Part 4, 1987, Paper No. 87-SP-170. This paper describes the model transformation and lists equalities that define short faults. A criterion for distance relaying is derived. The design of a polyphase distance relay is then presented. Some simulated test results are included to demonstrate the performance of the relay.

Traveling Wave Distance Protection-Problem Areas and Solutions, E.R. Shehab-Eldin and P.G. McLaren, IEEE Trans. on Power Delivery, Vol. 3, No. 3, July 1988, p 894-902. This paper examines some problem areas and suggests new techniques to improve distance protection based on traveling waves. A complete correlation output is used to recognize reflections from the fault and distinguish them from reflections from discontinuities behind the relay. Effects of insulation angle are compared; fault resistance effects and external faults are also examined.

Polarizing Sources for Directional Relaying, W.M. Strong, 43rd Annual GA Tech Protective Relaying Conference, 1989. This paper is a reference document that describes methods of polarization that are used to accomplish directionalility in relays.
Transmission Line Relaying Using Microprocessors, S.A. Uffen and Hung Jen Li, 43rd Annual GA Tech Protective Relaying Conference, 1989. This paper presents two original approaches to the design of digital line protection - stand-alone digital transmission line relays, and the line protection modules which are an integral part of relaying and control systems for an entire substation.

3152.2 PILOT WIRE, CARRIER AND MICROWAVE

A Differential Line Protection Scheme for Power Systems Based on Composite Voltage and Current Measurements, R.K. Agarwal and A.T. Johns, IEEE Trans. on Power Delivery, Vol. 4, No. 1, Jan. 1989, p 1595-601. This line relaying system derives differential signals from currents and voltages measured at each end of the line. This approach avoids the need for relay bias to compensate for capacitive currents and permits greater sensitivity than that can be achieved with a current only differential scheme.

Fiber Optic Channels for Protective Relaying, IEEE Power System Relaying Committee Report, IEEE Trans. on Power Delivery, Vol. 4, No. 1, Jan. 1989, p 165-76. This paper provides relay engineers with a general description of fiber optic hardware, methods of modulation, application considerations, and testing. The economics of a multi-fiber optic system is discussed. Available relaying equipment, including equipment which interfaces existing pilot wire relays to optical fibers, is described.

LFCR Current Differential Relay for Use with Digital Communication Systems, B. Ling and W.S. Kwong, Trans. CEA 860 Div., Vol. 27, Part 4, 1988, Paper No. 88-SP-156. The paper describes a microprocessor based current-differential transmission line relay designed for use with digital communication systems. The advantages of the relay are discussed. The requirements of digital communication systems, with emphasis on optical fiber systems, both multiplexed and dedicated, are addressed.


Application Consideration of Fiber-Optic Channels for Protective Relaying, R.E. Say, 42nd Annual GA Tech Protective Relaying Conference, 1988. The groundwork for the reader to further study the topic of fiber-optics is presented. Some of the topics covered include: why fiber-optics in protective relaying, main components of fiber-optic systems, system performance calculations, and application notes.


3152.3 RELAY SYSTEMS


Development of a Substation Digital Protection and Control System Using Fiber-Optic Local Area Network, M. Suzuki, T. Matsumoto, H. Kashi and V. K. V. Jha, IEEE Trans. on Power Delivery, Vol. 4, No. 3, July 1989, p 1668-75. The paper describes a new system that has been developed and is in trial use at a 500 kV substation. Digital protection and control equipment are located close to the outdoor power apparatus and are linked by a fiber optic network. The equipment configuration and networking system are discussed.

Integrated Metering and Protective Relay Systems, S.E. Hocholl, IEEE Trans. on Industry Applications, Vol. 25, No. 5, Sept/Oct 1989, p 889-91. Digital real-time and real-time computation of voltage and current phasors by low cost microprocessors make metering, event recording, and fault locating an integral part of a protective relay system. These systems perform a range of functions in maintainable software, such as, self diagnostics. They use unified hardware, and provide a significant reduction in cost per function.

3153 RELAY INPUT SOURCES


3154 ROTATING MACHINERY PROTECTION

Factors Influencing the Protection of Small-to-Medium Size Induction Generators, J.D. Bailey, IEEE Trans. on Industry Applications, Vol. 24, No. 5, Sept/Oct 1988, p 955-64. The performance and unique characteristics of induction generators, as they relate to the protection of the units of several kw to 1500 kw, are discussed. The differences in protection suggested for synchronous and induction units are provided. The concern of overvoltage due to self-excitation of induction generators under load rejection is also addressed. Minimum protection recommendations are given.

protecting high voltage motors.

Large Induction Motors - Field Test on Locked Rotor Protection, R.G. Fairley and L.G. Hajos, IEEE Trans. on Power Delivery, Vol. 3, No. 2, Apr. 1988, p 488-93. Large motors with high inertia loads often require longer starting times than locked rotor protection permits. The paper describes the authors’ experience in solving the problems of nuisance trips during start-up. The test results are provided to assist in proper setting of supervising distance relay.


Summary of the "Guide for AC Generator Protection" ANSI/IEEE C37.102-1987, IEEE Power System Relaying Committee Report, IEEE Trans. on Power Delivery, Vol. 4, No. 2, Apr. 1989, p 965-74. A significant number of large machines have been damaged on being accidently energized when off-line. This report describes the problem, the hazard to the generator and turbine, and the major dedicated protection schemes employed within the industry to detect this condition.

Design Aspects of Torness Main Generator Protection, R.A. Martin, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989, p 95-62. This paper describes the provision for a 685 MW generator at the Torness advanced gas cooled nuclear station of the South of Scotland Electricity Board.

Determining Relay Settings for Motor Protection Using Published and Empirical Data, P.W. Powell and S.E. Zocholl, 43rd Annual GA Tech Protective Relaying Conference, 1989. This paper describes the relation between the thermal limit curves and the published parameters of an induction motor and shows how to use this data to determine relay settings for the thermal and fault protection of the stator and rotor.

Analysis of Ground Protection of Unit Connected Generators Using Third Harmonics, S. Shinew and S. Birnbaum, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989, p 45-50. This paper describes the ground protection provided for a 685 MW generator at the Torness advanced gas cooled nuclear station of the South of Scotland Electricity Board.

Relay Performance in DEG Islands, C.L. Wagner, W.E. Pepper, W.H. Gish and R.H. Jones, IEEE Trans. on Power Delivery, Vol. 4, No. 1, Jan. 1989, p 122-31. Field tests were made with isolated DEGs to confirm the existence of self excitation, ferroresonant, and high resistance conditions. A number of voltage and frequency relays were installed and their performance monitored. Problems which became apparent are discussed.

Design and Application of Protection Relay Schemes for Internal Faults in Stator Windings of a Large Hydro-Generator with Multi-Branch and Distributed Arrangement, K.H. Wang, L.Z. Zhang, W.J. Wang and Z.H. Yu, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989, p 51-5. A technique described in this paper protects a large generator with multiple stator windings. An algorithm for calculating currents due to faults in one of the loops is also described.

New Developments of Third Harmonic Ground Fault Protection Schemes for Turbine-Generator Stator Windings, W. Wei, W. Xiaoqing and Z. Xiling, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989, p 250-3. This paper introduces a third harmonic equivalent circuit of turbine-generator stator windings and uses the equivalent circuit to analyze stator ground fault protection schemes.

3155 TRANSFORMER, BUS, CAPACITOR, AND REACTOR PROTECTION

Load Shedding Scheme of Jordanian National Power System, M.F. Abusharkh and A.A. Hayasat, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989, p 96-101. This paper describes the load shedding scheme used by the Jordan Electricity Authority. The decisions are made using four parameters, voltage, frequency, rate of change of frequency and time.

An Automatic Transfer Scheme Using a Programmable Controller, M.F. Best, 43rd Annual GA Tech Protective Relaying Conference, 1989. This paper explains the basic operating characteristics of a station transfer scheme and describes the evolution from a component relay scheme to a programmable controller scheme.

Monitoring and Fault Protection of High Voltage Switchgears by the Hemet Method, D.W.E. Blatt, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989, p 167-71. Current measurements by remote magnetic field monitoring instrument transformers is described in this paper. Sensing coils are located at each segment but at a safe distance from the high voltage conductors. Field measurements are converted to currents in the conductors using a matrix with the shunt couplings between the conductors and the sensing coils.


System Back-up Protection - A New Approach, F.C. Chan, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989, p 331-5. The basic requirements of system back-up protection are outlined in this paper. A new approach, that used earth fault relay with current dependent time-lag characteristic, provides system back-up protection. The application of the proposed technique is demonstrated by using a 400 KV model system.

The Application of System Control Centre Computer Assisted Special Protection Systems in Ontario Hydro, D.R. Cowbourne and P.M. Murphy, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989, p 156-61. A transmission line fault on the Ontario Hydro system could result in disconnecting
critical lines, limiting the ability of the system to transport power generated at the Bruce Nuclear Power Station. This paper describes a control scheme for rejecting nuclear generation on the inception of faults on selected lines.


Practical Considerations in Protecting Gas-Insulated Substations Using Transformer Differential Relay, N. Funimoto, Trans. CEA ESO Div., Vol. 26, part 1, 1987, Paper No. 87-A-60. Insulated flanges are commonly used at the interface between gas-insulated substations and high pressure oil filled ("pipe type") cables. This practice provides galvanic corrosion protection of the cable pipe. The practical considerations of techniques for protecting the insulating flanges are discussed for both new designs and retrofits for existing installations.


Study of the Non-Operation for Internal Faults of Second Harmonic Restraint Differential Protection of Power Transformers, G.S. Hope, O.P. Mallik, D. Chen and F. Liu, Trans. CEA ESO Div., Vol. 28, Part 4, 1989, Paper No. 89-SP-141. This paper presents a study on the non-operation of second harmonic restraint differential protection for faults in transformers. To quantify the existence of this problem, algorithms are analyzed for a large number of faults and energization of a transformer. The sample data used is based on on-line tests of a laboratory transformer. Modified schemes to solve this problem are presented.


A Rationalised Policy for Application and Setting of Back-up Protection on the CEGB Supergrid System, R. Inglesfield, 4th Int. Conf. on Developments in Power System Protection, IEEE Pub. No. 302, 1989, p 301-5. This paper reviews the need for back-up protection on the CEGB supergrid. A back-up protection scheme for feeders, bus sections and couplers, and transformers is proposed. The performance objectives and a relay setting policy for back-up protection are outlined.

Computer Algorithms for Selection of Frequency Relays for Load Shedding, J.R. Jones and W.D. Kirkland, IEEE Computer Applications in Power, Vol. 1, No. 1, Jan 1988, p 21-5. This paper describes the selection of frequency relays and the method of setting under-frequency load shedding relays. The method iteratively calculates the relay setting in software while changing parameters, thereby optimizing the design.

Primary Protection for Network Transformers, J.A. Rieszky, Trans. CEA ESO Div., Vol. 25, Part 1, 1987, Paper No. 87-D-47. This paper reviews the requirements for distribution transformer protection and describes the equipment developed to meet the physical and electrical requirements for interrupting devices installed in transformer vaults.

A Microprocessor Based Protective System for Generator-Transformer Units, I. Korbasiewicz, H. Korbasiewicz and W. Winkler, 4th Int. Conf. on Developments in Power System Protection, IEEE Pub. No. 302, 1989, p 56-60. A general concept of protecting a generator-transformer unit is described in this paper. The proposed relays are divided into three groups. It is proposed that each group of relays be implemented on a 16-bit microprocessor.

A New Detection Scheme for Realization of Magnetizing Inrush Current in Transformers. K.C.Y. Ling and A. Basak, 4th Int. Conf. on Developments in Power System Protection, IEEE Pub. No. 302, 1989, p 239-44. This paper describes a model used to determine the second harmonic components of the magnetizing inrush currents in single-phase and three-phase transformers. An algorithm for detecting the magnetizing inrush conditions is then proposed.

A New Look at Trip Circuit Design - The Lifeline of Protective Relaying, L.C. Lunsford, R.B. Bliss, 42nd Annual CA Tech Protective Relaying Conference, 1988. This paper discusses the relationship of the various components in the trip circuits and their impact on each other. Older schemes are not always compatible with newer equipment. The problems encountered by one utility are discussed.


Developments in Transformer Protection, P. Maddett and R. Niven, 4th Int. Conf. on Developments in Power System Protection, IEEE Pub. No. 302, 1989, p 61-5. This paper describes a digital transformer protection system which includes differential and overcurrent functions. Ratio balance, phase angle correction and zero sequence current removal are achieved in the software. Magnetizing inrush and overfluxing are detected by the presence of second and fifth harmonics respectively.

Design of a Digital Protection Scheme for Power Transformers using Optimal State Observers, Y.V.V.S. Murty, W.J. Smillie and P. Sivakumar, IEE Proceedings-C, Vol. 135, No. 3, May 1988, p 224-30. The design of the software for a transformer protection relay is described in this paper. The state observer approach is used for estimating the fundamental and harmonic components in the currents. Results from the application of this approach to the data obtained from laboratory tests are presented.

Protection and Design of Shunt Capacitor Banks With Internally Fused Capacitors, G. C. Parr. 42nd Annual GA Tech Protective Relaying Conference, 1988. This paper discusses the differences in the protection required when capacitor banks are built using internally fused capacitors instead of the traditional external fuses.


Low Impedance Biased Differential Busbar Protection for Application to Busbars of Widely Differing Configuration, J. B. Royle and A. Hill. 4th Int. Conf. on Power Transformers in Power System Protection, IEEE PUb. No. 302, 1989, p 40-44. High impedance and low impedance biased differential techniques for busbar protection are briefly described. A technique described in the paper detects a fault at the source and ensures operation for internal faults and stability during external faults.

A Digital Relaying Algorithm for Detecting Transformer Winding Faults, W. S. Sachdev, T. S. Sidhu and H. C. Wood. IEEE Trans. on Power Delivery, Vol. 4, No. 3, July 1989, p 1638-48. This paper describes a new digital algorithm for detecting winding faults in single-phase and three-phase transformers. The algorithm, based on the electromagnetic equations of a transformer, is suitable if it is or it is not possible to measure winding currents. The results of the tests show that the algorithm performs well.

Detecting Transformer Winding Faults Using Non-Linear Models of Transformers, T. S. Sidhu, W. S. Sachdev and H. C. Wood. 4th Int. Conf. on Developments in Power System Protection, IEEE Pub. No. 302, 1989, p 70-4. This paper describes an algorithm for detecting faults in three phase delta-wye transformers. The technique models the transformer as a non-linear device and compares the operating parameters observed at the primary and secondary terminals.

Novel Ways of Protection and Control Equipment Accommodation, J. E. Starke, 4th Int. Conf. on Developments in Power System Protection, IEEE Pub. No. 302, 1989, p 136-40. This paper describes techniques for accommodating protection and control equipment at new and existing substations. The techniques provide reductions in lifetime costs and overall engineering time without sacrificing availability and reliability.

New Approaches to Differential Relaying/Solid State Power Transformer Protection, W. N. Strang. 42nd Annual GA Tech Protective Relaying Conference, 1988. This paper presents a general overview of transformer differential protection and specific considerations to factors such as, magnetizing inrush and harmonic restraint. The paper reviews two new relay designs and outlines the advantages of their application for transformer protection.

Expert System Application in Substation Monitoring, Back-up Protection and Control, J. Treanor and W. J. unpublished, 4th Int. Conf. on Developments in Power System Protection, IEEE Pub. No. 302, 1989, p 75-8. The implementation of an expert system for protection and control of a substation is considered in this paper. The organization of the system and the functions performed by each module are outlined.

3156 FAULT AND SYSTEM CALCULATION METHODS


AASPE/EN One Line: A Computer-Aided Relay Coordination Program, S. Chany, 43rd Annual GA Tech Protective Relaying Conference, 1989. This paper describes a computer-aided relay coordination program which combines in one program the elements of a CAD (computer-aided design) package, a short circuit program, and a relay coordination program.

Fault Locators Reduce Outage Time, D. H. Deverell and D. E. Shields. Transmission and Distribution, Aug. 1988, p 56-62. This paper describes the application of fault locating relays on subtransmission and distribution lines to minimize customer outage time. One relay which uses the current on the load side of a power transformer is used to locate faults on several distribution circuits.

Utility Solves Problem of Communications Protection at High Voltage Sites, L. L. Duva, Transmission and Distribution, Jan. 1988, p 34-6. This paper describes techniques for calculating the ground-potential-rise due to nearby power line faults. It also outlines the guidelines used to safely terminate a communication entrance cable, and shows the benefits of having protective safeguards in place.

New Algorithm for Distance Protection of High Voltage Transmission Lines, M. Pikri and N. H. Al-Sayed, IEEE Proceedings-C, Vol. 135, No. 5, Sep. 1988, p 436-40. The technique described in this paper estimates the location of a transmission line fault from instantaneous data sampled at the line terminals. It is essential that the sampling data at the two line terminals be synchronized. The simulation results presented in the paper show the accuracy of the expected results.

loads, ground resistance, temperature, etc. Worked examples show how software is used to reduce the time an engineer needs to study the problem.

Application of Adaptive Kalman Filtering in Fault Classification, Distance Protection, and Fault Location using Microprocessors, A.A. Girgis, E.B. Marks, and IEEE Trans. on Power Systems, Vol. 3, No. 1, Feb. 1988, p 301-9. The current and voltage data of each phase is processed in two Kalman filter models simultaneously. One model assumes that the phase is not faulted and the other assumes that the phase is faulted. Convergence of estimates and observations determines the apparent resistance and reactance to the fault.


Use of Data Compression Techniques in Digital Fault Recorder, L. Roller and P. Lucas, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989, p 18-22. This paper briefly describes a digital fault recorder which can store its local memory data of thirty events over a five second duration. This is achieved partly by using a data compression technique.


New Accurate Transmission Line Fault Location Equipment, A.T. Johns, S. Jamali and S.H. Haden, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989, p 1-5. This paper describes a technique for estimating the distance of a transmission line fault from the relay locations. A distributed parameter model of the line is used in this technique.

Harmonic Behavior During Arcing Faults on Power Distribution Feeders, C.J. Kim and B.D. Russell, Electric Power Systems Research, Vol. 14, 1988, p 219-25. The waveforms of normal and arcing fault currents on power distribution feeders are investigated. The amplitude of the waveform is compared with the amplitude of the normally observed fundamental frequency component. The purpose of the study is to find parameters that indicate arcing faults.

A Step Forward: Automatic SEF Data Acquisition and Analysis, D.S. Kolbenschlag, 42nd Annual GA Tech Protective Relaying Conference, 1988. This paper describes one utility’s system for remote acquisition of data from sequence of event recorders. The method of retrieving data and separating from it data that is pertinent to a specific disturbance is discussed.


Transmission Line Modeling for Short-Circuit Calculations, A.P. Mallopolous and A.H. Ayoub, 42nd Annual GA Tech Protective Relaying Conference, 1988. Error analysis of power line parameters and cases in which this error may be unacceptable are discussed. Also presented is a new algorithm for computing the sequence parameters of power lines.

Graphics Relay Coordination Analysis Using an Integrated Short Circuit Module, R. Ramaswami, A. Poumansky, P.F. Mogile, and D.M. MacGregor, 43rd Annual GA Tech Protective Relaying Conference, 1989. This paper concentrates on two modules (Coordination Graphics and Short Circuits) of a computer-aided protection engineering program. Actual examples are given using a portion of the Georgia Power Company system.

Computer Aided Coordination of Directional Relays: Determination of Break Points, V.V.B. Rao and Y.S. Rao, IEEE Trans. on Power Delivery, Vol. 3, No. 2, Apr. 1988, p 542-5. Break points are the network locations where directional overcurrent relays have minimum settings. A technique for determining the break points is described. This technique could be incorporated in a computer-aided relay setting package.

A Technique for Estimating Transmission Line Fault Locations from Digital Impedance Relay Measurements, R.S. Sachdev and R. Agarwal, IEEE Trans. on Power Delivery, Vol. 3, No. 1, Jan. 1988, p 121-9. Recorded data from both ends of a line plus the known line impedance are used to calculate the apparent fault impedance from each terminal, the fault resistance, and the location of the fault. The technique does not require synchronized data or source impedances. The procedure for all common fault types and test results are described.

A Review of Impedance-Based Fault-Locating Techniques, E.O. Schweitzer, 43rd Annual GA Tech Protective Relaying Conference, 1989. This paper reviews the fundamental fault-locating principles and field experience. It also discusses and analyzes special cases, and points out how fault locating has benefited protection as well as operation of power systems.

A New Fault Location Algorithm for Radial Transmission Lines with Loads, K. Sinivasan and A. St. Jacques, IEEE Trans. on Power Delivery, Vol. 4, No. 3, July 1988, p 1676-82. Conventional fault location schemes applied to radial lines have errors if loads are neglected. A new method, which takes loads into consideration, is proposed in this paper. Single phase to ground, phase to phase, and three phase to ground faults are considered.

Reliability Expectations for Protective Relays, J.G. Andrichak, C.R. Heising and R.C. Patterson, 42nd Annual GA Tech Protective Relay Conference, 1988. Discussed are various aspects of performance and reliability of electromechanical and solid-state relays. Also presented are some guidelines for the application of different types of relays based on their expected performance and functions.


Performance Assessment and Control of Power System Relays, F.C. Chan, IEEE Trans. on Power Delivery, Vol. 4, No. 2, Apr. 1989, p 886-94. In this paper, the basic protection system design is examined, the method of measuring protection performance is presented, and control measures on various protection activities are discussed. Several approaches to evaluating equipment reliability are discussed and a method of developing a performance index is presented.


Influence of Harmonics on Power System Distribution System Protection, J.F. Fuller, E.F. Fuchs and D.J. Koesler, IEEE Trans. on Power Delivery, Vol. 3, No. 2, Apr. 1988, p 546-54. Tests were made on a static underfrequency relay, two static overcurrent relays, and an electromechanical overcurrent relay (pickup only). A single harmonic was added to the fundamental frequency with magnitude and phase controlled. The results and commentary are given.

Computer Simulation of Current Transformers and Relays for Performance Analysis, R.M. Garrett, W.C. Kotherer and E.E. Escholtz, 42nd Annual GA Tech Protective Relaying Conference, 1988. The use of low ratio, low accuracy class current transformers in switchgear applications exposes many relays to grossly distorted currents. This paper describes a computer simulation of these waveforms and shows how the results can be used as an economical means to verify relay operation.

Time Synchronous End-to-End Relay Testing, S.M. Harphan and J.A. Jodicke, 4th Int. Conf. on Developments in Power System Protection, IEEE Pub. No. 302, 1989 p 244-9. A method for synchronizing and controlling protection test instruments at remote locations using Geo-Stationary or Global Positioning satellite receivers is presented in this paper. Test methods suitable for end-to-end testing of protection systems are also suggested.

Reliability Expectations for Protective Relays, C.R. Heising and R.C. Patterson, 4th Int. Conf. on Developments in Power System Protection, IEEE Pub. No. 302, 1989 p 23-5. The failure rates of electromechanical and electronic relays are reviewed in this paper. The effects of self testing, reliability prediction, and performance test procedures are then considered.


Ground Resistance – revisited, D.I. Jeerings and J.R. Linders, IEEE Trans. on Power Delivery, Vol. 4, No. 2, Apr. 1989, p 949-55. The nature of ground resistance is examined to explain the high impedance of faults to the ground wire or grounded structures. The harmonics of the resulting current may be used to distinguish high impedance faults from load conditions.

Five Years’ Experience with a New Method of Field Testing Cross and Quadrature Polarized Mho Distance Relays; Part 1: Results and Observations; Part 2: Three Case Studies, W.D. Kennedy, B.J. Gruel, C.H. Shih and Y. Vee, IEEE Trans. on Power Delivery, Vol. 3, No. 3, July 1988, Pt. 1, p 880-6; Pt. 2, p 887-93. A new method has been used to test relays from different manufacturers, to successfully predict and improve distance relay discrimination and to solve unexplained relay operations. Problems that arise from using the new method are discussed. Part 2 describes two case studies that show what the elements of the relay connected to the unfaulted phases do. A 3rd case study determines the boundary of a relay with a complex characteristic.

Dyn-Test Simulator: Protective Relaying Teaching Tool, M. Kuzmanovic, IEEE Trans. on Power Systems, Vol. 4, No. 3, Aug. 1989, p 1305-10. A Dynamic Testing Simulator concept, to be used as a teaching tool, is proposed. Instead of fault analysis and protection methods based on the steady-state concept, fault transients may be analyzed. The examples discussed focus on teaching different approaches to the design of measurement algorithms.

relays under test. Use of a 3kHz band width signals provides proper signals for testing travelling wave relays. Field recorded fault data can also be used.

Experience With a Modern Real-Time Power System Simulator. H. Saha and B. H. Williamson, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989 p 6-12. An analog power system simulator controlled by a digital computer is described in this paper. The operational experience with the simulator is briefly outlined.


Preventive Maintenance can Reduce Outages, P. Todd, Electric Power and Light, Vol. 66, No. 2, Feb. 1988, p 20. This paper describes the benefits of maintenance of transformers, breakers, relays, and control and communication equipment.

Computer Controlled Protection Testing -- A Western Australian Experience, A. Tunnicliffe, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989 p 35-9. This paper describes the digital relay testing equipment jointly developed by the State Energy Commission of Western Australia, ACEF -- a private company and the University of Western Australia. One design is for the equipment to be used in the field and the other for laboratory equipment.

Automated Testing of Power System Protection Relays, A.C. Webb, Power Eng. J., (UK), Vol. 2, No. 6, 1988, p 291-8. The author describes the requirements for automatic test facilities and then goes on to discuss hardware, software, and test routines. Test results and field experience are described.

Computer Generation of Test Quantities for Testing Protection Relays, A.C. Webb, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989 p 30-6. An automatic relay testing set which can use data generated by its own software or digital data provided by the user in an appropriate format, is described. The software applies test quantities including the polarizing voltages to the relays being tested.

The Management of the Commissioning of the Protection of Torness Power Station and Substations, A. Young, 4th Int. Conf. on Developments in Power System Protection, IEE Pub. No. 302, 1989 p 321-5. This paper describes various aspects of commissioning protection system of the Torness power station and substation commissioning tests performed on power station equipment and systems are briefly described.


3158 SYSTEM STABILITY, OUT OF STEP PROTECTION, AND SERVICE RESTORATION

Experience with Voltage Feed-Through on TRV/Gradient Capacitor on High Voltage Circuit Breakers, F.R. Drum, 43rd Annual GA Tech Protective Relaying Conference, 1989. This paper recounts the experience one utility has had with buses and transformers energized by transient recovery voltage (TRV)/gradient capacitors across open circuit breaker contacts.

A Programmable Controller for Protective Relay Logic, F. Karun, Trans. CEA EAO Div., Vol. 26, part 3, 1987, Paper No. 87-SB-146. A microprocessor-based programmable controller provides the auxiliary logic in protective relaying. It offers advantages of continual self-monitoring, and a sequence of events recording feature for testing and post-fault analysis. It allows field programmability of settings for software timers, counters and switches, and local or remote retrieval of sequence of events information.

A Microprocessor-Based Intelligent Load Shedding Relay, W.J. Lee and J.C. Gu, IEEE Trans. on Power Delivery, Vol. 4, No. 4, Oct. 1989, p 2018-24. Load shedding relay settings should be adjusted often to satisfy changing system conditions. The paper describes a relay which can re-adjust to a higher setting after a partial recovery occurs. The time delay is also adjusted if an unbalanced fault causes sustained low frequency.

A Microprocessor Based Special Protection System, R.J. Malewicz and J.A. Whatley, Trans. CEA EAO Div., Vol. 28, Part 4, 1989, Paper No. 89-SB-144. This paper describes the need for the design of a microprocessor based Special Protection System for monitoring abnormal operating conditions in the Ontario Hydro's 500 kV system in the vicinity of the Bruce Nuclear Power Development and for performing control actions in the form of generation rejection/ runback, tertiary reactor tripping, and load shedding.


Publication
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IEEE Transactions & Conf. Papers
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ASA Journal
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