BIBLIOGRAPHY OF RELAY LITERATURE, 1996
IEEE COMMITTEE REPORT

Members of the Bibliography and Publicity Working Group of the IEEE Power System Relaying Committee are:
T.S. Sidhu, Chairman, M. Bajpai, A. Darlington, D. Finley, A.G. Folkman, M. Kezunovic,

ABSTRACT - The latest of a series of classified lists of power system relay ing 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:

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1995 - Paper # 96 SM 412-7 PWRD

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

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

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

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

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

ADDITIONAL REFERENCES

Electrical & Electronics Abstracts, are published monthly by the Institution of Electrical Engineers (U.K.) and the Institute of Electrical and Electronics Engineers, Inc. (USA).
Papers and journals published in several countries are covered.

3150 RELAYING ALGORITHMS


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

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


3151 DISTRIBUTION AND NETWORK PROTECTION

3151.1 Industrial and Power Station Auxiliaries

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

3151.2 Primary Distribution Systems

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


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

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


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

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

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

3152 TRANSMISSION LINE PROTECTION

3152.1 Distance and Ground Relaying

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

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


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

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

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

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


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

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

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

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


3152.2 Relay Communications

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

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

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

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


3152.3 Relay Systems


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

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

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

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

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


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

**3153 RELAY INPUT SOURCES**

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


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

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

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

**The Rogowski Coil and the Voltage Divider in Power System Protection and Monitoring**, P. Mähönen, M. Moisio, T. Hakola, H. Kuisti, CIGRE, Aug 25-31, 1996, Paper No. 34-103. New solutions are proposed for measuring current and voltage in power system protection and monitoring. The well-known principles of the Rogowski current sensor and the voltage divider are shown to be capable of meeting the new requirements. These sensors have become technically feasible due to the introduction of micro-processors in the secondary equipment.
3154 ROTATING MACHINERY PROTECTION

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

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

Numerical Generator Protection, A. Kazemi, F. Oliveira, H. Meier, 50th Annual Georgia Tech Protective Relaying Conference, May 1-3, 1996. This paper examines the advantages of numerical technology as it relates to generator protection. A multi-function protection system is described and a number of generator protection functions are examined in detail. The self-supervision feature as it relates to the protection system availability and the future maintenance requirements is discussed.
Delivery, Vol. 11, No. 1, Jan 1996, p 227-33. The paper addresses the aspects related to the design and installation of a bridge capacitor bank between the 138kV and 69kV substation buses, including relay protection and control. The bridge capacitor bank is operated in conjunction with a 69 kV shunt capacitor bank, and in parallel with an autotransformer.

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

**315.3 Other Protection**

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


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

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

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


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


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

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


**3156 FAULT AND SYSTEM CALCULATIONS**

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

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

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

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

A New Technique, Based on Voltages, for Fault Location on
Three-Terminal Transmission Lines, J. F. Minambres, I.
Zamora, A. J. Mazon, M. A. Zorrozua, R. Alvarez-Isasi,
A new method for fault location on three-terminal
transmission lines is described in this paper.

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

Line Monitoring and Fault Location Using Spread Spectrum
on Power Line Carrier, V. Taylor, M. Faulkner, IEE
transmitted over the power line carrier system are used to
locate faults and other impedance mismatches on EHV
transmission lines. Prototype hardware and on-line results
are presented for a 225 km, 330 kV line.

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

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

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

Fault Location on Two-Terminal Transmission Lines Based
on Voltages, I. Zamora, J.F. Minambres, A.J. Mazon, R.
1, 1996, p 1-6. The fault location method proposed in this
paper is based on fundamental component of pre- and post-
fault voltages measured at two ends of a transmission line.
The methodology allows establishment of a direct calculation
procedure that is independent of currents, fault type, fault
resistance and synchronization condition at line ends.

3157 MAINTENANCE, TESTING, ANALYSIS, AND
MODELING

Digital Simulators Expedite Relay Performance Evaluation,
Mark G. Adamiak, Suparna G. Saldanha, IEEE Computer
Digital simulators present a new development tool for real-
time simulation techniques and automation of protective
relay testing.

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

High Impedance Fault Detection Tester, V. L. Bucholtz, M.
Nagpal, J. B. Nelson, R. Parisi-Feraldoonian, W. Zarecki,
184-90. Relays are becoming available to detect HIFs by
distinguishing the signatures of high impedance arcsing
faults. Successful testing of these relays requires the
playback of recorded waveforms from a library of field
recordings of HIFs and feeder loads. A test protocol evaluates both dependability and security from false alarms.


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


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

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


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


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

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


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


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


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

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

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

Statistical Performance Measures for Protective Relays, E.A. Udren, 23rd Annual Western Protective Relay Conference, Oct 15-17, 1996. This paper summarizes the work of an IEEE Working Group for measuring the performance of protective relaying systems. The paper shows how to
calculate mean time before failure and categorizes misoperations and relay system failures.

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

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


3158 STABILITY, OUT OF STEP, RESTORATION

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


3159 SURGE PHENOMENA

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