

results on a part of the Saskatchewan Power (SaskPower) network have been presented in this paper. The restoration practices of the SaskPower network have been collected and stored in a knowledge database called case library. The power flow and the implementation risk analysis tools have been incorporated into the expert system. A risk analysis tool has been used to determine the implementation risk due to the imperfect switching actions. Using the GUI, a user can simulate a blackout event on the system under study. The expert system proposes a restoration proposal after reasoning with the past solutions available in the case library. Using the power flow analysis tool, the user can check the system scenarios after the restoration proposal is implemented.

**Keywords:** Power systems, restoration, expert systems, case-based reasoning, graphic package.

**Preprint Order Number:** PE-465PRS (01-2001)

**Discussion Deadline:** To be determined

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## Power System Analysis, Computing, and Economics

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### A General Polling Algorithm Using a Wireless AMR System for Restoration Confirmation

Fischer, R.; Laakonen, A.; Schulz, N.

**Author Affiliation:** Michigan Technological University, Houghton, MI

**Abstract:** Restoration of distribution systems is a complicated process, especially after storms, when a large number of outages can occur. Many utilities are implementing automated meter reading (AMR) systems that can aid in the restoration process. This paper presents work done to utilize the capabilities and information provided by a wireless AMR system, including the on-demand read feature, to develop a polling procedure to identify system conditions. It takes advantage of the connection information provided by a utility and the performance of the wireless meter communication systems.

### 2001 International Conference on AC-DC Power Transmission

28-30 November 2001  
London, UK

The seventh International Conference on AC-DC Power Transmission will be held 28-30 November 2001 in London, UK. Emphasis is on new projects, methods, solutions, technology, and concepts. The conference is for engineers, managers, and consultants involved with the operation and planning of transmission and distribution systems or with the development and design of equipment for FACTS and/or HVDC. Academic contributors to the development of the industry are also welcome. The conference is organized by the Power Division of the Institution of Electrical Engineers (IEE), and the IEEE Power Engineering Society is a technical cosponsor. The conference will be coordinated and overlap with the 2001 Power Cables Conference, 26-28 November 2001.

For more information, contact the ACDC01 Secretariat, IEE Event Services, Savoy Place, London WC2R 0BL, UK, +44 0 20 7344 5471/5398, fax +44 0 20 7240 8830, e-mail [acdc01@iee.org.uk](mailto:acdc01@iee.org.uk), Web <http://www.iee.org.uk/Conf/ACDC>.

**Keywords:** Power distribution, power system restoration, outage management systems, automated meters.

**Preprint Order Number:** PE-672PRS 01-2001

**Discussion Deadline:** To be determined

### An Alternative Approach to Adaptive Single-Pole Auto Reclosing in High-Voltage Transmission Systems Based on Variable Dead Time Control

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**Abstract:** This paper presents a new concept, based on variable dead time control, in adaptive single-pole auto reclosing (SPAR). The proposed scheme can give rise to a high rate of successful reclosing by adapting to variable dead times. The significance of this algorithm is that it uses the waveform patterns of the voltage transients following initial breaker opening. The performance of this proposed method is tested under a variety of fault locations on the Korean 765 kV system, and the outcome of the study clearly indicates that variable dead time auto-reclosing scheme can be used as an attractive and effective means of better management and operation of a high-voltage transmission system.

**Keywords:** Adaptive single-pole auto reclosing, high-voltage transmission lines, dead time control.

**Preprint Order Number:** PE-002PRD (01-2001)

**Discussion Deadline:** To be determined

### Reliability and Costs Optimization for Distribution Networks Expansion Using an Evolutionary Algorithm

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**Author Affiliation:** University of La Rioja, Spain; University of Zaragoza, Spain

**Abstract:** This paper presents a multiobjective optimization methodology, using an evolutionary algorithm, for finding out the best distribution network reliability while simultaneously minimizing the system expansion costs. A nonlinear mixed integer optimization model, achieving the optimal sizing and location of future feeders (reserve feeders and operation feeders) and substations, has been used. The proposed methodology has been tested intensively for distribution systems with dimensions that are significantly larger than the ones frequently found in the papers about this issue. Furthermore, this methodology is general since it is suitable for the multiobjective optimization of  $n$  objectives simultaneously. The algorithm can determine the set of optimal nondominated solutions, allowing the planner to obtain the optimal locations and sizes of the reserve feeders that achieve the best system reliability with the lowest expansion costs. The model and the algorithm have been applied intensively to real-life power systems showing its potential of applicability to large distribution networks in practice.

**Keywords:** Power distribution systems, optimal design, evolutionary algorithms.

**Preprint Order Number:** PE036PRS (01-2001)

**Discussion Deadline:** To be determined

### A Greedy Randomized Adaptive Search Procedure for Transmission Expansion Planning

Binato, S.; Oliveira, G.C.; Araújo, J.L.

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**Abstract:** A greedy randomized adaptive search procedure (GRASP) is a heuristic method that has shown to be very powerful in solving combinatorial problems. In this paper we apply GRASP to solve the transmission network expansion problem. This procedure is an expert iterative sampling technique that has two phases for each iteration. The first, construction phase, finds a feasible solution for the problem. The second phase, a local search, seeks for improvements on

construction phase solution by a local search. The best solution over all GRASP iterations is chosen as the result.

**Keywords:** Transmission expansion planning, integer problems, heuristics, GRASP.

**Preprint Order Number:** PE-776PRS (01-2001)

**Discussion Deadline:** To be determined

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## Power System Instrumentation and Measurement

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### A Precise Calculation of Power System Frequency

Yang, J-Z.; Liu, C-W.

**Author Affiliation:** National Taiwan University, Taipei, Taiwan

**Abstract:** A precise digital algorithm based on discrete Fourier transforms (DFT) to estimate the frequency of a sinusoid with harmonics in real time is proposed. This algorithm, which we call the smart discrete Fourier transform (SDFT), smartly avoids the errors that arise when frequency deviates from the nominal frequency, and keeps all the advantages of the DFT (e.g., immune to harmonics and the recursive computing can be used in SDFT). These make the SDFT more accurate than conventional DFT-based techniques. In addition, this method is recursive and easy to implement, so it is suitable for use in real time. We provide the simulation results compared with a conventional DFT method and second-order Prony method to validate the claimed benefits of SDFT.

**Keywords:** Discrete Fourier transforms (DFT), frequency estimation, phasor measurement.

**Preprint Order Number:** PE-072PRD (01-2001)

**Discussion Deadline:** To be determined

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## Power System Planning & Implementation

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### Using Utility Information to Calibrate Customer Demand Management Behavior Models

Fahrioglu, M.; Alvarado, F.

**Author Affiliation:** The University of Wisconsin-Madison

**Abstract:** In times of stress customers can help a utility by means of voluntary demand management programs if they are offered the right incentives. The incentives offered can be optimized if the utility can estimate the outage or substitution costs of its customers. This paper illustrates how existing utility data can be used to predict customer demand management behavior. More specifically, it shows how estimated customer cost functions can be calibrated to help in designing efficient demand management contracts.

**Keywords:** Demand management, contract design, customer cost, data calibration, load curtailment, system security.

**Preprint Order Number:** PE-106PRS (01-2001)

**Discussion Deadline:** To be determined

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## Power System Relaying

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### Optimal Computation of Distance Relays Second Zone Timing in a Mixed Protection Scheme with Directional Overcurrent Relays

Perez, L., Urdaneta, A.

**Author Affiliation:** Universidad Simon Bolivar

**Abstract:** This paper describes a technique to determine the optimal time setting for the second zone of distance relays when used in a mixed protection scheme with directional overcurrent relays. The technique consists of including the second zone operation time as a new variable in the original problem statement of optimal computation of directional overcurrent relays settings. It is shown that the influence of distance relays and directional overcurrent relays must be considered when the settings of these relays are computed. Numerical results obtained with the proposed method for a realistic power system are presented.

**Keywords:** Power system protection, relay coordination, optimization techniques.

**Preprint Order Number:** PE-154PRD (01-2001)

**Discussion Deadline:** To be determined

### A Novel Digital Distance Relaying Technique for Transmission Line Protection

Eissa, M.M.; Masoud M.

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**Abstract:** Parallel transmission lines often pose more difficult protection problems than single lines. In the case of parallel lines, a number of problems arise when using the distance protection. This paper discusses problems associated with parallel line distance relaying schemes and presents a novel technique to overcome these problems. Two relays instead of four are proposed for the double lines. One relay is located at the beginning and another one at the end. Each relay is fed by three voltage and six current signals from the two lines. The suggested technique is based on the comparison of the measured impedance of corresponding phases. So, the complexity of the possible types of faults, high path fault resistance, mutual effects, current in-feed, inter-system faults are solved. Moreover, 100% of line is protected and the problem of balance-point lo-

## 2001 Universities Power Engineering Conference

12-14 September 2001  
Swansea, UK

The thirty-sixth Universities Power Engineering Conference (UPEC 2001) will be organized by the Department of Electrical and Electronic Engineering, University of Wales Swansea, UK, and will be cosponsored by IEEE. It will be held on the main University Campus on 12-14 September 2001. The conference will address topics in all areas of power engineering, including renewable energy sources, power generation, transmission and distribution, power system analysis, power system operation and control, electrical machines and drives, power electronics, high voltage engineering, power utilization, and power engineering education.

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