State Estimator Condition Number Analysis

Ebrahimian, R.; Baldick, R.

Author Affiliation: The University of Texas at Austin, TX

Abstract: This paper develops formulas for the condition number of the state estimation problem as a function of the different types and number of measurements. We present empirical results using the IEEE RTS-96 and IEEE 118 bus systems that validate the formulas.

Preprint Order Number: PE-113PRS (02-2001)

Calculation of Energy Transaction Allocation Factors

Fradi, A.; Brignone, S.; Wollenberg, B.

Author Affiliation: University of Minnesota, MN

Abstract: The ability to allocate the MW loading on transmission lines and groups of lines is the basis of NERC's "flow based" transmission allocation system. In such a system, the MW flows must be allocated to each line or group of lines in proportion to the MW's being transmitted by each transaction. This is accomplished through the use of the linear power transfer distribution factors. Unfortunately, no linear allocation models exist for other transmission phenomena such as MW losses, MVA flows, etc. This paper presents a methodology to calculate energy transaction allocation factors (ETA factors, or η factors), using the well-known process of integration of a first derivative function. The factors give a highly accurate allocation of any nonlinear transmission system quantity to the active transactions placed on a transmission system.

Keywords: Energy transaction allocation factors, trapezoidal integration method, Newton power flow

Preprint Order Number: PE-069PRS (02-2001)

Reactive Power as an Ancillary Service

Bhattacharya, K.; Zhong, J.

Author Affiliation: Chalmers University of Technology, Göteborg, Sweden

Abstract: This paper addresses the problem of reactive power procurement by an independent system operator (ISO) in deregulated electricity markets. A reactive bid structure is proposed in the context of a reactive power market. Based on the reactive power price offers and technical constraints involved in reactive power planning, a two-tier approach is developed to determine the most beneficial reactive power contracts for the ISO. The reactive capability of a generator and, therefore, the opportunity costs in providing reactive power is also included in the model. Uncertainty in reactive demand and in reactive bids of participating parties is incorporated through Monte Carlo simulations and the expected reactive power procurement plan for the ISO is hence determined. The CIGRÉ 32-bus network, approximately representing the Swedish system, is used for the studies.

Keywords: Deregulation, independent system operator, ancillary services, reactive power, Monte Carlo simulation.

Preprint Order Number: PE-039PRS (02-2001)

Nonconvex Economic Dispatch by Integrated Artificial Intelligence

Lin, W.M.; Cheng, F.S.; Tsay, M.T.

Author Affiliation: National Sun Yat-Sen University, Taiwan; Cheng-Shiu Institute of Technique, Taiwan

Abstract: This paper presents a new algorithm by integrating evolutionary programming (EP), tabu search (TS), and quadratic programming (QP) methods to solve the nonconvex economic dispatch problem (NED). A hybrid EP and TS were used for quality control and the Fletcher's quadratic programming technique was used for solving. EP and TS determine the segment of a cost curve used, which is piecewise quadratic natured. Operation constraints are modeled as linear equality or inequality equations, resulting in a typical QP problem. Fletcher's QP was chosen to enhance the performance. The fitness function is constructed from priorities without penalty terms. Numerical results show that the proposed method is more effective than other previously developed evolutionary computation algorithms.

Keywords: Nonconvex economic dispatch problem (NED), economic dispatch with piecewise quadratic cost function (EDPQ), economic dispatch with prohibited operating zones (EDPO), evolutionary programming (EP), tabu search (TS), quadratic programming (QP), genetic algorithm (GA), distance, adaptive decay scale, mutation scale.

Preprint Order Number: PE-012PRS (02-2001)

A Practical Hydro, Dynamic Unit Commitment and Loading Model

Siu, T.K.; Nash, G.A.; Shawwash, Z.K.

Author Affiliation: Resource Management, BCH, Prince George, B.C., Canada; University of British Columbia, Vancouver, B.C., Canada

Abstract: We describe the dynamic unit commitment and loading (DUCL) model that has been developed for use in real-time system operations at BC Hydro (BCH) to determine the optimal hydroelectric unit generation schedules for plants with multiple units and complex hydraulic configurations. The problem is formulated and solved with a novel procedure that incorporates three algorithms. First, an expert system is used to eliminate infeasible and undesirable solutions. Second, dynamic programming is used to solve the optimal static unit commitment problem for a given plant loading, feasible unit combinations, and current hydraulic conditions. Third, the DUCL problem is formulated and solved as a large-scale network problem with side constraints. Output from the model includes DUCL schedules, spinning and operating reserve, and tradeoff curves such as that between water usage and the number of unit switches. The innovative use of the procedure allows the model to effectively schedule hydro units for the energy and capacity markets in real-time. Application of the method is demonstrated by determining the 24-time-step DUCL schedule for a 2700 MW plant with ten units of four different unit types.

Keywords: Hydroelectric power generation scheduling, hydro unit commitment, dynamic programming, network programming, expert systems.

Preprint Order Number: PE-023PRS (02-2001)

Switchgear

Condition Assessment of Power Transformer On-Load Tap-Changers Using Wavelet Analysis

Kang, P. Birtwhistle D.

Author Affiliation: Queensland University of Technology, Brisbane, Australia

Abstract: The operation of a power transformer on-load tap-changer (OLTC) produces a well-defined series of vibration bursts as its signature. Due to the harmonic and nonstationary nature of the transient vibration signal traditional frequency and time-frequency techniques are on longer effective for characterization of this type of vibration signals as the localized time domain features—such as delays between bursts, the number of bursts, and the strengths of bursts—are essential for the condition assessment of OLTC. A wavelet transform-based technique is developed in this paper to characterize the OLTC vibration signals. This technique gives a simplified format for displaying and representing the essential features of the OLTC vibration signatures. Application results from a selector type OLTC demonstrate that the features extracted in the wavelet domain can be utilized to provide reliable indications of the actual heath of an OLTC.

Keywords: On-load tap-changer (OLTC), wavelet transform, transient vibration, condition assessment.

Preprint Order Number: PE-008PRD (02-2001)