trary initial solution, feasible or unfeasible, be the optimal solution of the OPF problem. As the scalar parameter changes, a family of OPF problems is created, whose necessary conditions are solved by Newton's method. An efficient strategy is proposed for updating the parameter and the optimal set of active inequality constraints of each intermediate problem. Two applications of the methodology are reported: the economic dispatch problem and the minimum transmission loss problem. These problems were solved for an 810-bus and a 2256-bus equivalent network of the South/Southeast interconnected Brazilian power system. The results show that the parametric approach is robust and efficient when applied to large-scale OPF problems.

Keywords: Continuation method, Newton's method, optimal power flow, updating active set.

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Discussion Deadline: October 2001

Gaming and Price Spikes in Electric Power Markets

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Abstract: Many challenging issues arise under the newly deregulated competitive electric power markets. Instead of centralized decision-making in a vertically integrated environment as in the past, decision-making is now decentralized and driven by market forces. Gaming and price spikes have been observed in almost every electricity market but explicit analysis of these phenomena is rare. In this paper we study historical bidding behavior to see how power suppliers and demand service providers were actually bidding in the California day-ahead energy market. Based on our observations we formulate a Prisoner's dilemma matrix game and introduce the notion of "opportunistic tacit collusion" to explain strategic bidding behaviors in which suppliers withhold generation capacity from the market to drive up prices. This explanation is applicable with or without market power, transmission constraints, and insufficient supply, and is only enhanced by these factors. Our analysis is generally applicable to any uniform price electricity market in which there is significant insensitivity to price on the demand side.

Keywords: Electric power industry deregulation, game theory, market clearing price, market power.

Preprint Order Number: PE-040PRS (05-2001)

Discussion Deadline: October 2001

Risk Assessment for Transformer Loading

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Abstract: A risk-based probabilistic method is presented to assess transformer loading capability, taking into account the probabilistic nature of time-varying loads and ambient temperature. A sample calculation, with both component-level analysis and system-level analysis, is given. Quantitative reference risk levels are obtained based on reference loading levels given by IEEE/ANSI C57.115-1991. It shows that our quantitative risk assessment is useful in assessing transformer loading and in aiding related decision making. An additional benefit is that it enables inclusion of transformer loading in composite system risk analysis.

Keywords: Transformer loading capability, risk assessment, probability, Monte Carlo simulation, loading cycle.

Preprint Order Number: PE-005PRS (05-2001)

Discussion Deadline: October 2001

Power System Dynamic Performance

Robust Design of a Damping Controller for Static Var Compensators in Power Systems

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Abstract: This paper presents a systematic procedure for the synthesis of a supplementary damping controller (SDC) for static var compensators (SVC) in multimachine power systems. The robust performance in terms of the structured singular value (SSV or μ) is used as the measure of control performance. A wide range of operating conditions are used for testing. Simulation results on standard test systems show that the resulting SDC effectively enhances the damping of the interarea oscillations, providing robust stability and good performance characteristics both in frequency domain and in time domain.

Keywords: Static var compensator, damping controller, μ-synthesis.

Preprint Order Number: PE-353PRS (05-2001)

Discussion Deadline: October 2001

Dynamic Security Corrective Control by UPFCs

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Abstract: This paper deals with the development of a nonlinear programming methodology for evaluating corrective actions to improve the dynamic security of power systems when transient instability is detected. Remedial actions are implemented by exploiting the fast response of unified power flow controllers (UPFCs). The algorithm is implemented and tested on the Italian grid.

Keywords: Dynamic security assessment, UPFC, corrective actions, transient stability.

Preprint Order Number: PE-038PRS (05-2001)

Discussion Deadline: October 2001

Simulation and Optimization in an AGC System after Deregulation

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Abstract: In this paper, the traditional AGC two-area system is modified to take into account the effect of bilateral contracts on the dynamics. The concept of DISCO participation matrix to simulate these bilateral contracts is introduced and reflected in the two-area block diagram. Trajectory sensitivities are used to obtain optimal parameters of the system using a gradient Newton algorithm.

Keywords: Power system control, deregulation, automatic generation control, bilateral contracts, optimization, trajectory sensitivity.

Preprint Order Number: PE-034PRs (05-2001)

Discussion Deadline: October 2001

Power System Operations

Hydrothermal Scheduling by Augmented Lagrangian: Consideration of Transmission Constraints and Pumped-Storage Units

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Abstract: This paper presents an augmented Lagrangian (AL) approach to scheduling a generation mix of thermal and hydro resources.