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Chronological simulation for transmission reliability margin evaluation with time varying loads

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ABSTRACT

This paper has as objective to assess the chronological variations in the Available Transfer Capability (ATC) caused by uncertainties associated with hourly load fluctuations and equipment availabilities. The system states resulting from these uncertainties are generated using the Monte Carlo Method with Sequential Simulation (MCMSS). The ATC for each generated state is evaluated through a linear optimal power flow based on the Interior-Point Method. These ATC values have been used to generate the probability distribution of the hourly ATC. This probability distribution enabled to estimate the Transmission Reliability Margin (TRM) for a specified risk level. The results, with a modified version of the IEEE Reliability test System, demonstrate that the time dependent uncertainties have a significant impact on the TRM.

1. Introduction

The restructuring of the electric sector has been stimulated by the economic benefits to society resulting from the deregulation of other industries such as telecomunications and airlines. Currently, electrical utilities around the world are undergoing a radical transformation from an essentially regulated and monopolistic industry to a new model characterized by competition in generation with guaranteed access to open transmission [1].

The supply competition and the open transmission services have caused an increase in the number of transactions among market agents such as generation/distribution companies, pool companies and brokers [2,3]. The transactions carried out among these agents are defined by market forces without considering engineering problems of controlling, operating and planning of an electrical power system. Consequently, there may exist transactions that violate system operation constraints, that is, unfeasible transactions. Nevertheless, the transmission expansion has not been stimulated. This situation has been caused by right-of-way constraints and investment limits for the power sector budget due to economic difficulties. These constraints have compelled transmission providers to operate the interconnections near to their limits. Due to this operating condition new indices have been developed with the objective of providing a quantitative assessment of the power transfer reliability, among them the ATC.

The ATC is a measure of the transfer capability remaining in the physical transmission network for future commercial activity over and above already committed uses [4]. Consequently, the ATC is subject to uncertainties in system parameters such as: generation dispatch patterns, load fluctuations and equipment (lines and generators) availabilities. These uncertainties may cause significant variations in the ATC. Due to this, the North American Electric Reliability Council (NERC) has recognized the importance of including the system uncertainties in the ATC evaluation [4].

Usually, the impact of system uncertainties on the ATC has been assessed using probabilistic methods [5–13]. These methods have been preferred due to their capacity to model, not only the severity of a state or event and its impact on system behavior and operation, but also the likehood or probability of its occurrence. The combination of severity and probability provides indices that really express the system risk [14–17].

The probabilistic assessment of power transfers consists basically of two main steps: the selection of a system state and the power transfer evaluation for the selected state. The power transfer evaluation for a system state was carried out using both nonlinear [5–10] and linear [11–13] models of the electrical network. On the other hand, the most used technique for the state selection is the Monte Carlo Method (MCM) with non-sequential simulation [7–13]. The MCM with non-sequential simulation can accurately model uncertainties associated with equipment availabilities and load forecast errors. These uncertainties can be modeled without

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