**Constraint relaxation and cascading contingency monitoring: A risk-based approach**

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Transmission constraint violation can cause the infeasibility in security constrained economic dispatch (SCED) due to insufficient control flexibility. To eliminate this infeasibility, the approach of constraint relaxation (CR) is applied to expand the feasibility region of SCED problem. The current general industrial practice for solving the infeasibility of SCED is by adding the slack variable to relax the infeasible transmission constraint and penalize the slack variable with penalty cost in objective function. The deficiency of industrial method is that the penalty cost of slack variable is determined based on heuristic which does not control its effect on system security. In this dissertation, a risk-based constraint relaxation (RBCR) model is proposed for overcoming the deficiencies of the industry approach. RBCR produces feasible solutions via constraint relaxation with controlled risk exposed to the system. In this approach, the thermal limits of individual circuits are relaxed while the exposed risk is controlled simultaneously; this approach prevents the artificial selection of penalty prices, therefore reduces the tendency of locational marginal prices (LMPs) spike in the electricity market.

To reflect the inter-temporal effect of CR, the multi-interval look-ahead SCED, which simultaneously optimizes the binding interval and several look-ahead advisory intervals, is applied to co-optimize the production cost and system risk in the multi-interval SCED model. Based on the initial system condition and time variant effects of transmission thermal limit, the methodology of predictive risk-based constraint relaxation is developed, which utilizes inter-temporal effects, as well as managing conduct temperature. The risk metric is proposed, and it is used by constraining it so that the effects of constraint relaxation on system security can be controlled. The methodology of predictive risk-based constraint relaxation has been tested and investigated on both the representative IEEE test system and a contrived model of an actual independent system operator (ISO) network. With the increasing penetration of variable energy resources, system operation incurs an increasing amount of uncertainty. In the framework of stochastic risk-based constraint relaxation, the concept of conditional value at risk (CVaR) is utilized to develop the alternative risk indices. Based on alternative risk metric, the methodology of two-stage stochastic constraint relaxation is formulated and tested on a representative network. The testing results indicate that the methodology of RBCR has a better performance than that of industrial model of constraint relaxation, in terms of operation cost and system risk. Furthermore, it can effectively reduce LMPs spikes with maintain the appropriate congestion signal unmasked.

Nevertheless, not all circuits are available for constraint relaxation. To identify weak areas under an operating condition, actionable risk-indicators are developed for cascading contingency monitoring. The cascading tree is generated according to the propagation risk, and then the cascading tree risk is utilized to evaluate the propensity of cascading contingencies at an operating condition. Application of circuit risk is beneficial for system operators to identify abnormal condition. Finally, effective re-dispatch is recommended for risk mitigation. The theory of risk-based stress monitoring for cascading contingency is examined on an IEEE test system.