ABSTRACT

The electric power industry throughout the world has been under the trend of deregulation. The new structure creates independent entities that include generation companies, transmission companies, distribution companies and retailer companies. The new paradigm promotes privatisation which leaves customers choices to select power sources. This leads to competition among generating companies. The competition is performed in a platform, created under deregulated environment, called as market. Market holds different models that include single buyer, bilateral and poolco. Irrespective of market, scheduled power transaction is performed between in-merit suppliers and buyers. In-merit generating unit schedules power to meet contracted power. However, in-merit buyers may violate the contract. In such case, the willing generating unit reschedules its output to meet the unscheduled power. The scheduling and rescheduling of power generation in each unit is performed with the help of load frequency control.

Major research works have been carried out to model load frequency controller under different markets, incorporating contribution factors of each generating unit in meeting market and violation powers. Various tuning methods have been proposed and employed by many researchers to improve the performance of controller. However, researchers fail to provide diverse contribution factors in the model for different market models. In addition, models proposed by researchers are analysed with assumed random values and no method is furnished to compute these factors from market settlement. Most of the researchers have emphasized on centralized controller for Load Frequency Controller to improve its performance under deregulated environment. No work has been carried out to identify the best controller among centralized and decentralized controllers. All literatures employ tie line bias control that maintains power flow through transmission line equal to contract value. This is possible by prohibiting generating units in neighbouring areas to contribute for the unallotted power. Moreover, the reserve in transmission line is left unutilized.

In this research work, the mathematical model of load frequency control for two area hydro thermal system under different markets is proposed. The model incorporates diverse participation factors for different markets. This factor is termed as GENCO participation factor (under single buyer model), contract participation factor (under bilateral model) and area participation factor (under poolco model). The participation of willing generating units
to meet the unscheduled power demand is termed as economic participation factor. A mathematical formulation is developed to compute these factors from market settlement data. The computed values are incorporated in the model and the performance is analysed. For the developed model, the best secondary proportional integral controller is chosen among Ziegler Nichols’ tuned centralized, Ziegler Nichols’ tuned decentralized and Genetic Algorithm tuned decentralized controllers using the performance index, integral square error.

The conventional tie line bias control strategy is then replaced by GENCO reserve based strategy, to allow economic and willing generating units in neighbouring area to compensate the violated demand. The proposed strategy is then analysed during contract violation under different markets. Though GENCO reserve based control strategy allows effective operation of load frequency controller, it fails to limit the power flow through transmission line. Hence, this strategy is modified to GENCO and TRANSCo reserve based control strategy. In case of any violation that creates line congestion, this strategy allows neighbouring units to meet part of the unscheduled demand up to the maximum transfer capability limit of the line. The remaining unscheduled demand is met by same area units. The mathematical model of two area hydro thermal system under different market models are incorporated with GENCO and TRANSCo reserve based control strategy to test its performance.

The developed model incorporating computed participation factors and employing tie line bias control is found to successfully schedule and reschedule generating units based on participation factors. Based on the performance index, integral square error, Genetic Algorithm tuned decentralized controller shows unexcelled performance compared to Ziegler Nichols’ tuned centralized and decentralized controllers. Incorporation of proposed GENCO reserve based strategy allows economic willing neighbouring generating units to effectively participate for violated power, under all markets. However, fails to limit transmission lines flow. Conversely, the proposed GENCO and TRANSCo reserve based strategy allows economic willing neighbouring generating units to effectively and efficiently participate for violated power, considering transmission line congestion. The cost incurred in meeting the unscheduled power demand shows that proposed GENCO reserve and GENCO and TRANSCo reserve based control strategies are more economical than tie line bias control. Results obtained from various testing and analysis proves that the proposed GENCO and TRANSCo reserve based control strategy for load frequency control provides effective, efficient and economic operation of deregulated power system.