ABSTRACT

In the thesis, a comprehensive analysis of automatic generation control (AGC) of interconnected power systems by considering area control error (ACE) as an input signal to the integral controller and a self-component of ACE (SACE) as an input signal to the integral controller has been done. It is shown that ACE has one self-component and one mutual component. A modified self-component of ACE (MSACE) has been proposed to minimize the accumulation of inadvertent interchange. Gain settings of the integral controllers are optimized by using the integral squared error (ISE) technique. The effect of superconducting magnetic energy storage (SMES) unit on AGC has also been studied for two and three area interconnected power systems. For various scenarios, studies have been carried out for two area AGC system after deregulation. Performance of AGC has been studied after deregulation by considering a load following controller. A new control scheme has been proposed for the generating units taking part in load following which can also generate the uncontracted power demand in the steady-state in proportion to the ACE participation factors.

Chapter-1 introduces the various aspects of AGC in general and presents a critical summary of the past work reported in the literature. It clearly lays down the objectives and motivation of the research work presented in this thesis.

Chapter-2 presents the dynamic performances of AGC for two area and three area interconnected power systems. It is shown that area control error (ACE) can be divided into two components, i.e., one self-component (SACE) and a mutual component. Integral gain settings of the controllers are optimized by using ISE technique for two and three area systems. Analysis reveals that following a step load disturbance, when SACE is used as an error signal to the controller, it is capable of correcting the frequency, tie-power and time deviations to the zero in the steady-state. Analysis also reveals that a modified self-component of ACE (MSACE) when used as an input signal to the controller minimizes

the accumulation of inadvertent interchange in the steady-state along with correcting frequency, tie-power and time deviations.

In Chapter – 3, effect of an SMES unit on AGC of two and three area systems have been studied. Gain settings of integral controllers have been optimized by using the ISE technique in the presence of an SMES unit. Frequency deviation signal (ΔF) and area control error (ACE) signal are used for controlling the SMES unit. Simulation results reveal that the use of ACE signal for controlling the SMES unit may be preferred because it gives lower steady-state value of time deviation and inadvertent interchange accumulation. Further investigations also reveal that the use of SACE as an input signal to the integral controller, as well as, as an input signal to the SMES control logic improves the dynamic performances significantly and leads to less steady-state value of inadvertent interchange accumulation.

In Chapter-4, AGC of two area interconnected power system under deregulation has been studied. The mathematical model developed in this case considers that the demand signal directly goes to the input of the governor of each generating unit. Several cases are examined to study the performances of AGC after deregulation. Investigation reveals that when uncontracted power demand is absent, ACE participation factors affect only the transient behaviour but not the steady-state behaviour. If uncontracted power demand is present, ACE participation factors decide the distribution of uncontracted power in the steady-state. Thus, this excess power demand is taken care of by the GENCOs in the same area as that of DISCOs making the uncontracted demand. It has been observed that if AGC controller is present in the case of uncontracted power demand by any DISCO, frequency deviation eventually goes to zero and actual tie-power flow settles to the scheduled tie-power flow in the steady-state.

Chapter-5 describes a comprehensive feasibility study of providing competitive load following. A mathematical model of AGC and load for a restructured power system has been proposed by considering AGC controller as well as load following controller. The input to each load following controller has been taken to be the mismatch between the contracted power demand and generated power. Performances under several scenarios e.g. unilateral contract, bilateral contract, generating units not participating in load following etc have been studied. A new control logic for load following has been proposed to take care of the uncontracted power demanded by DISCOs.

Analysis reveals that, in the steady-state, generators which take part in load following generate the required contracted power. Further analysis reveals that at least one unit in each area must be under AGC to make the frequency deviations and tie-power error to zero and actual tie- power flow equal to scheduled tie-power flow in the steady-state. Analysis also reveals that, using the new control scheme, the generating units taking part in load following can also share the uncontracted power demand in proportion to their ACE participation factors.