Abstract Accurate modeling and parameters of high voltage (HV) grid are critical for stability research of system frequency. In this paper, simulation modeling of the system frequency was conducted of an interconnected power system with HV transmission lines in China. Based on recorded tripping data of the HV transmission lines, system parameters were identified by using genetic algorithm (GA). The favorable agreement between simulation results and recorded data verifies the validity of grid models and the accuracy of system parameters. The results of this paper can provide reference for the stability research of HV power grid.

Keywords high voltage (HV) grid, frequency stability parameter identification, primary frequency regulation (PFR)

1 Introduction

With the development of Chinese power industry and accumulation of experiences in running large-scale regional power networks that cover several provinces, the time for interconnecting regional power networks was coming. Electricity transmission from West to East China, across North-west Grid and Central China, made a great contribution to achieving energy resources optimization configuration. However, the weak relation following long distance brought about some new problems [1]. When an abrupt disturbance occurs, the difference of frequency regulation in multi-areas will lead to the uneven distribution of power response. The tie-line transmission may overload or fluctuate, which threatens the safety of the power system [2].

As one of the most critical parameters in electric system, frequency directly indicates system stability and the consistence of interconnected grid. System frequency should be maintained within a safe range under load disturbance [3]. Frequency oscillation has become an important factor that determines the power transmission ability of the high voltage (HV) tie line. Primary frequency control (PFC) is one of the important means to ensure power system security and stability. It can regulate short period random variation and response to emergency rapidly.

Many frequency analyses of HV interconnected grid were conducted, in which some models were built based on the transfer functions of one order models to replace the PFC of generating units [4,5] while some influencing parameters were based on the typical value instead of the actual one [6,7]. These analyses did not provide detailed models or parameters, making the conclusions lack of credibility.

This paper focused on the theoretical analysis and mathematic modeling of an HV interconnected power system. Based on the measured data after transmission line trip-out, it completed the parameter identification of the frequency model by using genetic algorithm (GA). The models and parameters could provide data support for frequency simulation, which would be significant for power system frequency control and stability analysis.

2 Accident description and HV connected areas modeling

The interconnected power system is shown in Fig. 1 which consists of three areas. Grid A, B, and C are connected by
HV transmission lines, of which, Grid B and Grid C contain other transmission lines with 500 kV.

2.1 Recorded accident data

Large power deviation occurred in the HV line in 2012. The maximum fluctuation reached by 5 percent of the capacity of Grid B. Finally the HV transmission line tripped out and the HV line between B and C lost approximately 3 percent of the active power. The recorded data by the phasor measurement unit (PMU) is depicted in Fig. 2.

As shown in Fig. 2, the frequency of Grid B and Grid C dropped approximately 0.1 Hz after the trip-out and the maximum deviation was approximately 0.2 Hz within 5 s. The frequency of Grid A started rising and the steady deviation arrived at approximately 0.05 Hz.

2.2 Frequency analysis modeling of HV grid

The model of system frequency for the HV grid is developed with the method of multi-area system. In view of multi-area system, the large power system is formed with several control areas and coupled with transmission lines. Assuming that all the generating units are equipped with speed droop, the frequency of disturbance area will change immediately when the trip-out of transmission line or load disturbance occurs. Other areas provide appropriate active power through the transmission lines to support frequency regulation. At the ending of primary frequency regulation (PFR), the system will reach a new equilibrium.