Interphase Power Controller Application to Mitigate Transmission Network Short Circuit Level

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Abstract. In the steady state condition, an IPC controls power flow by setting PST phase angle. In this paper, an efficient algorithm is presented to specify location and the IPC parameters as a fault current limiter including angels of phase shifting transformer (PST) and reactances of the reactor and the capacitor. As a case study, the algorithm is applied to Tehran Regional Electric Company (TREC) to reduce the Short Circuit Level (SCL) of critical transmission substations. The transient stability studies are performed in the transmission network with the installed IPC to verify the effective current limiting characteristic of IPC.

Key words

Component, IPC, Fault current limiting, Transient stability.

1. Introduction

Interconnection of large number of generating units and connection of networks may cause high Short Circuit Levels (SCL) that can exceed the interrupting capability of existing circuit breakers and associated substation equipments. Conventional methods to decrease the SCLs are:(a) separation of the system buses (split buses)[1], (b) application of current limiting equipments, like series inductors or superconducting devices and (c) upgrading of protection equipments with enough margins to handle the new SCL.

Nevertheless, the application of these measures should be done after a detailed study of the electric network performance, since deterioration is possible due to (a) increased active and reactive power losses, (b) reduction of power flow margins for steady state and (c) diminished operating reliability and flexibility. However, none of mentioned methods provide additional transmission capability or ability to control or redirect the power flow. Splitting the bus sections may mitigate the fault problem in relatively cost-effective manner, but the operating flexibility and reliability will be decreased. Getting official authorizations to change the existing bus configuration may be difficult. Series reactors can neither completely eliminate the fault currents nor effectively reduce transmission constrains. Under heavily loaded conditions, this option can cause problems for voltage regulation also. Upgrading the transmission system either by adding new lines, using existing resources efficiently, replacing the under rated circuit breakers and associated substation equipments are other options of overcoming the high SC (Short Circuit) problem, which have planning and engineering challenges.

Utilizing the IPC in power system network to reduce the fault current can be a alternative solution [2,3]. Also, IPC is one of the technologies that have been used to control the power flow in network lines. In this paper, the applications of IPC to reduce short circuit currents and improve the transient stability in Tehran Regional Electric Company (TREC) are discussed.

2. IPC Modeling

The IPC is not a new technology but it is not well known among power engineers. The working mechanisms of some types of IPCs, i.e., flexibility and speed of response put this technology in the category of FACTS devices [4,5]. A generic IPC model consists of two branches, one branch with an inductor in series with PST and the other branch with a capacitor in series with the PST (Fig. 1). For SC reduction, the reactance of the inductor and capacitor are selected to be equal (i.e., they are tuned to the fundamental frequency), so as to impose an infinite impedance to the short circuit current (SCC) only, while controlling power flow under normal and post-contingency conditions [6].