Chapter 3 Power System Electrical Transients

Power system transients are caused by sudden changes in the system topology or operating conditions. Such changes include, but are not limited to, system short-circuits, fault clearing, load switching, generator switching, transformer energization and line switching. The duration of the transient is determined by the system natural damping, which is typically on the order of a few milliseconds to a few hundred milliseconds.

Due to LC resonances in the system, the currents and voltages will typically exceed the ratings of power system equipment. As a result, the system equipment is subjected to great stresses and even damage — compromising the system reliability and availability. The characteristics of equipment particularly affected by transients in the system include: device thermal rating, device insulation withstand level, and mechanical tolerances for the generator, motor, and transformer windings. Therefore, understanding the principles that govern the system transients and their effect on system equipment is important for improving the system performance.

Aspects of system design particularly influenced by transient phenomena include: determination of equipment voltage and current ratings, design of overcurrent relay schemes for circuit breakers, insulation coordination, determination of arrester energy rating, and development of schemes to mitigate or reduce the effect of these phenomena on the system equipment (e.g. transformer energization through pre-insertion resistors).

This chapter contains three sections that review electrical transients in power systems with applications for common situations and protection practices. To enhance the tutorial value of the chapter, system modeling is simplified. These simplifications do not compromise the validity of the methods used or the solution accuracy. In practical studies of electrical transient phenomena, a simplified model may be used for the preliminary investigation of the system response. The sections in this chapter are: